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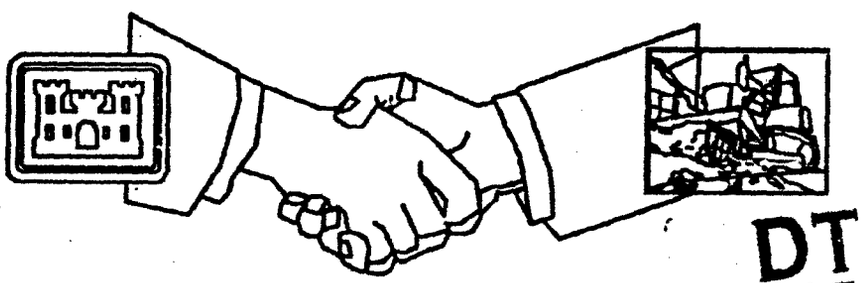
CONSTRUCTION PRODUCTIVITY ADVANCEMENT RESEARCH (CPAR) PROGRAM

Improved Materials and Processes for Sealing and Resealing Joints in Portland Cement Concrete Pavements–Field Evaluation

by

Larry N. Lynch, Dewey W. White, James Chehovits



A Corps/Industry Partnership to Advance
Construction Productivity and Reduce Costs

Construction Productivity Advancement Research (CPAR) Program

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October 1993

Improved Materials and Processes for Sealing and Resealing Joints in Portland Cement Concrete Pavements–Field Evaluation

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Final report

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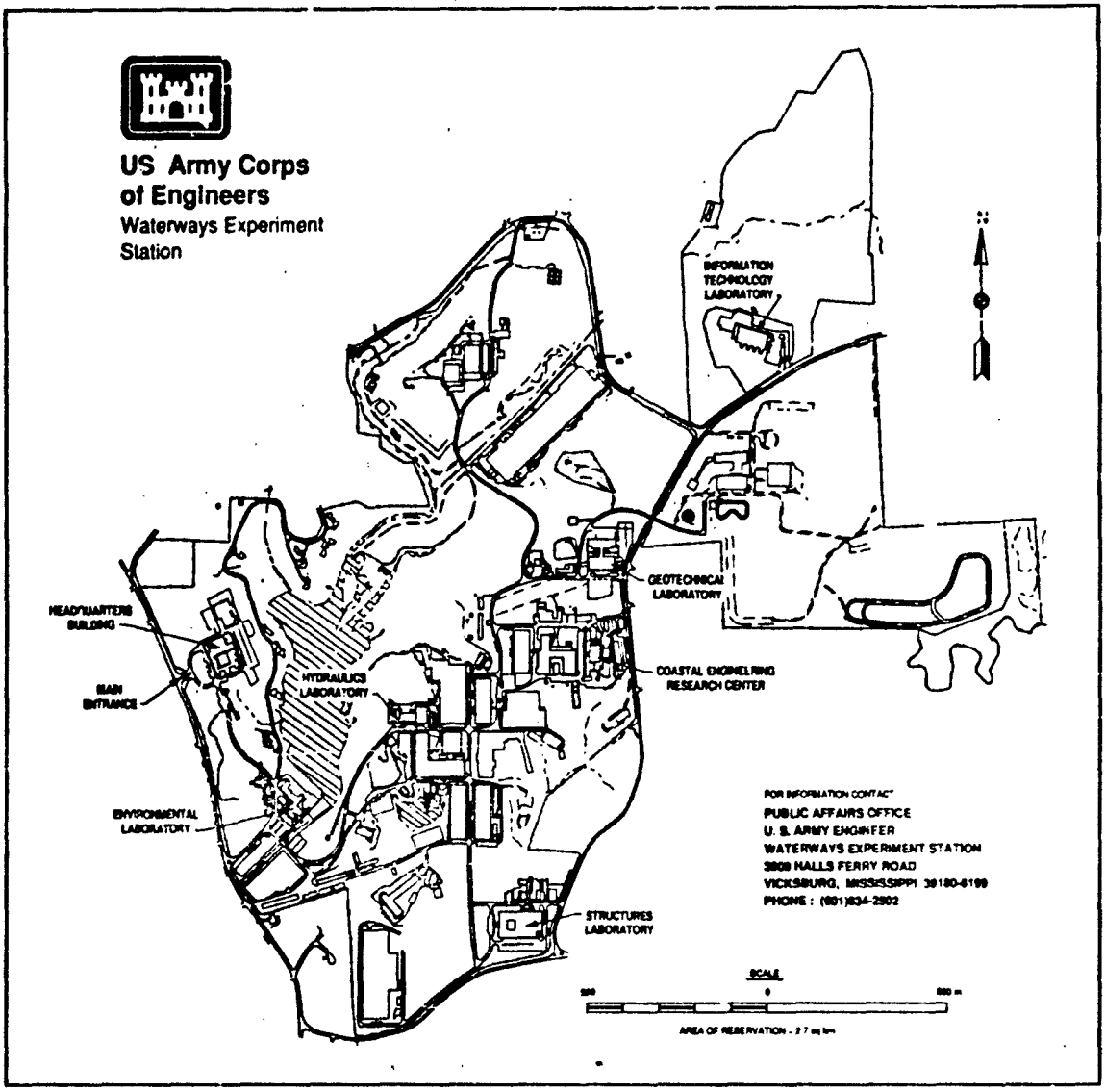

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Preface

Section 7 of the Water Resources Development Act of 1988, P.L. 100-676, 33 U.S.C. 2313, and the Stevenson-Wydler Technology Innovation Act of 1980, as amended, 15 U.S.C. 37012a, provide the legislative authority for the Construction Productivity Advancement Research (CPAR) Program. The CPAR program allows the U.S. Army Corps of Engineers to enter into cooperative research and development agreements with construction industry partners to conduct cost-shared, collaborative efforts with the goal of improving construction productivity.

The CPAR program "Improved Materials and Processes for Sealing and Resealing Joints in Portland Cement Concrete Pavements," was a collaborative effort between the Geotechnical Laboratory (GL) of the U.S. Army Engineer Waterways Experiment Station (WES) and Crafco Incorporated. The U.S. Army Corps of Engineers technical monitor was Mr. Gregory Hughes.

The project was conducted under the general supervision of Dr. W. F. Marcuson III, Director, GL, WES, and under the direct supervision of Mr. H. H. Ulery, Jr., former Chief, Pavement Systems Division (PSD), GL; Dr. George M. Hammitt II, current Chief, PSD, GL, Dr. R. S. Rollings, former Chief, Materials Research and Construction Technology (MR&CT), and Mr. T. W. Vollor, current Chief, MR&CT. Assistance during the field evaluations was provided by Mr. Ron Sanders, Fairchild AFB, WA, and Mr. Herbert McKnight, MRCT. The WES Principal Investigator was Mr. Larry N. Lynch and the Crafco Principal Investigator was Mr. James Chehovits. This report was prepared by Messrs. Lynch, Dewey W. White, and James Chehovits.

Dr. Robert W. Whalin was the Director of WES. COL Bruce K. Howard, EN, was the Commander

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Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
degrees	0.01745329	radians
Fahrenheit degrees	(F-32)/1.8	Celsius degrees
inches	2.54	centimetres
ounces (U.S. fluid)	0.02957353	cubic decimeters
square inches	6.4516	square centimeters
pounds (force) per square inch	6.894757	kilopascals

1 Introduction

Background

Many types and compositions of materials are currently used for sealing portland cement concrete (PCC) joints. These materials vary widely in chemical complexity, field performance, suitability for a specific application, and price. Currently, there are four "types" of sealants which can be specified on military projects. The specifications which cover these types of sealants are:

a. Federal Specification (FS) SS-S-1401C (1984a), "Sealant, Joint, Non-Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Asphalt Concrete Pavements."

b. FS SS-S-1614A (1984b), "Sealant, Joint Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Tar Concrete Pavements."

c. FS SS-S-200E (1988), "Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement."

d. U.S. Army Corps of Engineers Handbook for Concrete and Cement (CRD C) 527 (1992), "Joint Sealants, Cold-Applied, Non-Jet-Fuel-Resistant, for Rigid and Flexible Pavements."

FS SS-S-1401C sealants are asphalt-base, hot-applied materials normally used to seal cracks in asphalt cement pavements or joints in PCC pavements in areas where fuel spillage is not expected. Typical application areas are parking lots, roadways, and some taxiway applications. For personnel not familiar with federal specifications, FS SS-S-1401C is similar but not identical to American Society of Testing and Materials (ASTM) D 3405 (1978).

FS SS-S-1614A sealants are coal tar-base, hot-applied materials that are normally used to seal joints in PCC pavements where fuel spillage would be expected. Typical applications are maintenance areas and aircraft parking aprons. FS SS-S-1614A is similar to ASTM D 3569 (1991), with the exception of two or three additional tests that are included in ASTM D 3569 and ASTM D 3581 (1990).

FS SS-S-200E sealants are two-component, cold-applied materials and can be coal-tar, polysulfide, or polyurethane-based. These sealants are used to seal joints in PCC pavements where both fuel spillage and aircraft blast are expected. Typical application areas are aircraft warm-up areas, pavements that are exposed to vertical short takeoff landing (VSTOL) aircraft, and the ends of runways. Currently there is not an ASTM specification similar to FS SS-S-200E.

CRD C 527 sealants are cold-applied and can be either single or multi-component materials. CRD C 527 sealants are normally used to seal joints and cracks in either PCC or asphalt cement concrete pavements that are not exposed to fuel spillage. Typical areas where these sealants can be used are the same as the FS SS-S-1401C sealants. Currently there is not an ASTM specification similar to CRD C 527.

The above mentioned pavement joint sealants are manufactured for a specific use; however, an ideal sealant, regardless of the specification to which it was manufactured, would consist of certain characteristics. These ideal characteristics would include:

a. Simple and repeatable application techniques.

b. Maintains adhesion to joint faces when subjected to extreme temperatures and joint movements.

c. Insensitive to moisture.

d. Rejects incompressible materials.

e. Resistant to long term weathering.

f. Resistant to various de-icing chemicals.

g. Resists bubbling and/or blistering during application and service.

h. Economical.

Each sealant type; FS SS-S-1401C, SS-S-1614A, SS-S-200E, and CRD C 527, may contain one or more of these ideal characteristics; however, no one sealant contains all of them. The sealants manufactured to meet the requirements of FS SS-S-200E are arguably the most ideal sealant based on the list of ideal characteristics, but they can be difficult to install properly.

Field observations and evaluations conducted in recent years by various agencies have indicated problem areas associated with the sealing and resealing of joints in PCC pavements. Most of the problems or failures that have been observed are directly associated or can be traced to one or a combination of material, workmanship, and/or project specification deficiencies.

Objectives

Considering the characteristics of an ideal sealant and the types of problems and failures that have been encountered in the field, Crafco, Incorporated, and the U.S. Army Engineer Waterways Experiment Station conducted a cost-shared collaborative effort to investigate methods of improving pavement joint sealant performance. This program was funded under the auspices of the FY 89 Construction Productivity Advancement Research (CPAR) Program. The stated objectives of the research effort were as follows:

a. Improve the low temperature performance characteristics of existing hot-applied, jet-fuel-resistant (JFR) and non-jet-fuel-resistant (non-JFR) pavement joint sealant materials (or develop new materials to achieve the desired performance characteristics).

b. Develop a primer system that will minimize the bubbling tendencies associated with hot-applied sealants and improve the sealant's adhesion to PCC.

c. Develop field data to determine performance of flush fill sealant application geometry versus 1/8 to 1/4 in. recess application.

There are several test requirements in both ASTM and Federal specifications that a sealant must meet before it conforms to the specific specification. Failure of any one of the requirements constitutes non-conformance. These test methods were designed to identify the physical characteristics of joint sealant materials that would be advantageous for good field performance. For example, the penetration test provides an indication of how well a sealant will resist the puncturing effects of debris as traffic forces the debris into the sealant. Resilience provides an indication of how well the sealant will reject the debris after the force of traffic has been removed. However, these test do not necessarily predict how the sealant material will actually perform in the field. Joint preparation and sealant application are critical aspects of the finished product. Federal and ASTM specifications do provide a means for user agencies to compare different joint sealant materials and a method of quality control for the sealant manufacturer, but verification of actual field performance is required.

Purpose of Report

To accomplish the research objectives, the effort was divided into two phases. Phase I was a laboratory investigation which investigated improving the low temperature performance characteristics of hot-applied pavement joint sealant materials and the development of a primer system to minimize bubbling tendencies of hot-applied sealants. The Phase II effort was a field evaluation of the sealants and primer system developed in Phase I and was also used to evaluate the flush fill sealant installation geometry versus recessing the sealant below the pavement surface. The Phase II field evaluations also

included several commercially available sealants as a control group for field performance comparisons.

The purpose of this report is to document the Phase II Field Evaluation of the sealants. The Phase I Laboratory Investigation is documented in USAE Waterways Experiment Station Technical Report CPAR-GL-93-1 (Lynch, White, and Chehovits 1993).

The results from the field evaluations cover the materials installed in portland cement concrete pavements of airfields only as none of the materials were installed in pavements with high traffic rates typical of roads and streets.

2 Sealant Materials

Several hot-applied, asphalt-based and coal tar-based sealants were obtained for the Laboratory Phase of the project. The asphalt-based sealants were tested in accordance with FS SS-S-1401C and the coal tar-based sealants were tested in accordance with FS SS-S-1614A. Not all of the procured sealants were manufactured to meet the requirements of either Federal Specification, but the testing was conducted to characterize currently available hot-applied sealant materials. If the desired characteristics currently existed, there would not be a need to develop a new sealant. The sealants tested during the Laboratory Phase in accordance with FS SS-S-1401C were:

a. Crafco, Inc., RoadSaver 222, manufactured to meet or exceed the requirements of FS SS-S-1401C, ASTM D 1190, and ASTM D 3405.

b. Crafco, Inc., RoadSaver 231, manufactured to meet the requirements of a low-modulus modified ASTM D 3405.

c. Crafco, Inc., RoadSaver 299, manufactured specifically to seal joints or cracks in PCC or asphalt pavements in colder climates.

d. Crafco, Inc., 34515, manufactured to meet the requirements of state modified American Association of State Highway and Transportation Offices (AASHTO) M 173 (1990).

e. Koch Materials Company, Product 9030, manufactured to meet the requirements of a low-modulus modified ASTM D 3405.

f. Koch Materials Company, Product 9005, Manufactured to meet or exceed the requirements of FS SS-S-1401C, ASTM D 1190, and ASTM D 3405.

g. W. R. Meadows, Sealtight Sof-Seal, manufactured to meet the requirements of a low-modulus company developed specification.

h. W. R. Meadows, Sealtight Hi-Spec, manufactured to meet the requirements of FS SS-S-1401C and ASTM D 3405.

The sealants obtained and tested in accordance with FS SS-S-1614A were:

a. Crafco, Inc., Superseal 1614A, manufactured to meet the requirements of FS SS-S-1614A and ASTM D 3581.

b. Koch Materials Company, Product 9012, manufactured to meet the requirements of FS SS-S-1614A, ASTM D 3569, and ASTM D 3581.

c. Koch Materials Company, NEA-1614, manufactured to meet the requirements of FS SS-S-1614A and ASTM D 3581.

The test results of the as-received sealant samples indicated that not all of the sealants manufactured to meet federal specification requirements actually conformed to those specifications. These particular sealants would not have been approved for use on a military project because of the non-compliance. However, the test results should not be interpreted to mean that all sealants produced by the manufacturer would not conform to the appropriate specification. It simply indicates that the one lot number or batch number obtained for the investigation did not conform to the appropriate specification.

Not all of the joint sealant materials evaluated in the Laboratory Phase of the project were installed for field evaluation. The manufacturers of the particular joint sealants evaluated in the Laboratory Phase were provided the option of installing their material for field evaluation. The joint sealant materials that were evaluated in Phase I and also installed for field evaluation were:

a. Crafco, Inc., RoadSaver 222.

b. Crafco, Inc., Improved Non-JFR Sealant. This sealant is an asphalt-based material that has a lower modulus than sealants manufactured to meet the requirements of FS SS-S-1401C. The proposed specification for this type of sealant is provided in Appendix A.

c. Koch Materials Company, Product 9005.

d. Crafco, Inc., Superseal 1614A.

e. Crafco, Inc., Improved JFR Sealant. This sealant is a coal tar-based sealant that has a lower modulus than sealants manufactured to meet the requirements of FS SS-S-1614A. The proposed specification for this type of sealant is provided in Appendix B.

f. Koch Materials Company, Product 9012.

Several manufacturers were contacted by Crafco and WES and provided the option of installing commercially available sealants as a control group. The conditions for participation in the program were that each manufacturer was responsible for the cost of installing his material, and specification conformance test data must be provided for the actual lot or batch number of the sealant installed. The additional sealants that were installed for field evaluation were:

a. Crafco, Inc., RoadSaver Silicone SL.

b. Mobay Corporation, Baysilone 960.

c. Mobay Corporation, Baysilone 960 Self-Leveling.

d. Dow Corning Corporation, 902 RCS.

e. Dow Corning Corporation, 890 SL

f. Koch Materials Company, Product 9050 SL

g. Koch Materials Company, Product 9020.

A brief data sheet and the specification conformance test results for each sealant material installed for the field evaluation are provided in Appendix C. Additional manufacturers were contacted, but they chose not to participate.

Two of the manufacturers, Crafco, Inc., and Koch Materials Company, installed a primer in some of their test sections. The primer installed by Crafco, Inc., was developed during the Laboratory Phase of the project and was designed to minimize the bubbling tendencies of the asphalt-based, hot-applied sealants. The proposed specification for the developed primer is provided in Appendix D. Koch Materials Company installed two primers; one with their Product 9005 and one with their Product 9012. Both primers were designed to improve the sealant's adhesive properties. Data sheets for the primer materials are also included in Appendix C.

3 Test Plan

The test plan for the field evaluation of the sealant materials was very simple. Contract one contractor to prepare all of the joints to minimize discrepancies that could be caused by changes in preparation procedures. The procedures used to prepare the joints were sawing to reface the joint walls, flushing the joint with water to remove all saw residue. The joints were allowed to dry and were then sandblasted, cleaned with compressed air, and a backer rod was inserted. The sealant manufacturer's representative was allowed to examine the joints, note any discrepancies with the cleanliness of the joint, and then install his sealant.

A total of 750 linear feet of each sealant was installed in two 375 linear foot sections. Two sections only for each sealant were used due to funding constraints. The linear footage of primer used by Crafco, Inc., and Koch Materials Company was determined by the manufacturers representative. The sealant materials were divided into two groups; JFR and non-JFR. The definition of fuel-resistance was based upon the change-in-weight (solubility) test requirements of ASTM D 3569, ASTM D 3581, FS SS-S-1614A, and FS SS-S-200E. Each of these specifications allow no more than a 2 percent change-in-weight from the initial weight after conditioning in reference fuel B maintained at 120°F for 24 hr. The test area layouts for the sealant materials are provided in Figures 1 and 2. The sealants that correspond to each section are provided in Table 1. The location of the two test areas at Fairchild Air Force Base (AFB), WA, is shown in Figure 3.

The first evaluation of the in-place sealants was conducted during the actual application of the material. The second evaluation was conducted approximately 6 months (22 January 1992) after installation with the third evaluation conducted approximately 1 year (27 July 1992) after installation. The performance of the sealant was determined by noting the type and number of defects each sealant incurred. Figure 4 provides a sample evaluation sheet used during the field performance evaluation.

Once the layout for the field evaluation had been established, the site for installation of the sealant materials had to be selected. Two major items were used to identify possible sites for the field evaluation. The first and most important item was the site had to be located in an area that experienced cold weather. One of the main objectives of the project was to develop a material that exhibited improved low temperature field performance. The second

Table 1
Installation Areas and Sealant Types

Area	Sections	Sealant[1]
1	1 & 18	Crafco RoadSaver 222 installed with a 1/8- to 1/4-in. recess.
1	2 & 19	Crafco RoadSaver 222 installed using flush fill geometry.
1	3 & 20	Crafco RoadSaver 222 installed with a 1/8- to 1/4-in. recess. All joints were primed.
1	4 & 21	Crafco Improved Non-JFR Sealant installed with a 1/8- to 1/4-in. recess.
1	5 & 22	Crafco Improved Non-JFR Sealant installed using flush fill geometry.
1	6 & 23	Crafco Improved Non-JFR Sealant installed with a 1/8- to 1/4-in. recess. All joints were primed.
1	7 & 24	Crafco RoadSaver Silicone SL
1	8 & 16	Mobay Baysilone 960
1	9 & 15	Mobay Baysilone 960 Self-Leveling
1	10 & 17	Koch Product 9005, selected joints were primed
1	11 & 14	Dow Corning 902 RCS
1	12 & 13	Dow Corning 890 SL
2	1 & 6	Crafco Superseal 1614A
2	2 & 7	Crafco Improved JFR Sealant
2	3 & 9	Koch Product 9050 SL
2	4 & 10	Koch Product 9020
2	5 & 8	Koch Product 9012, selected joints were primed

[1] Some sections have more than one sealant material in the section. This occurred due to a lack of sealant material. The sections that have more than one sealant in them are shown in Figures 5-38.

criterion was that the site required resealing. Based on this criterion, Fairchild AFB in Spokane, WA, was selected. Fairchild AFB experiences an average daily temperature during January of 25°F and average low temperatures of 19°F. Extreme low temperatures of down to -30°F have been recorded, so the low temperature capabilities of the sealant will be tested. Conversely, the average daily temperature during August is approximately 70°F with the average high temperature being 84°F. Extreme high temperatures of up to 108°F have been recorded; therefore, the sealant's ability to withstand movement will also be tested.

4 Sealant Installation

The sealing project was initiated at Fairchild AFB, WA, on 10 June 1991 and was completed on 14 June 1991. A preconstruction meeting was held to ensure base personnel as well as the contractor and manufacturer representatives were aware of the project location, scheduling requirements, and for base personnel to explain the requirements that must be followed when working on the airfield. At this meeting, one of the manufacturers stated that he would provide his own contractor to clean and seal the joints. The manufacturer was more familiar with the capabilities of the second contractor, thereby believing that the use of a second contractor would expedite the process. The use of a second contractor was agreed to mainly because additional aircraft would be flying into Fairchild AFB and the base personnel would need access to the areas that were being sealed on 15 June 1991.

After the meeting, the two contractors, Blade Runners, Inc., of Phoenix, AZ, and National Concrete Cutting of Auburn, WA, began to prepare the joints for sealing. Both contractors used a water cooled concrete saw (Photo 1) to reface the joints to a width of approximately 3/4 in. Most of the old joint sealant material had been previously removed from Area 1 by Fairchild AFB maintenance crews. The old sealant in Area 2 was removed during the joint refacing using the concrete saws. Once the joints had been refaced, they were flushed using high pressure water equipment (Photo 2) to remove all debris left by the sawing operation. After the joints had dried, they were sandblasted and cleaned with compressed air (Photos 3 and 4) to complete the preparation process. To expedite the sealing process, all joints were prepared at the same time. The joints remained open for 1 to 2 days before sealing. Compressed air was used to clean the joints immediately prior to sealing, and the manufacturers inspected the joints for cleanliness and dryness.

Upon completion of joint preparation, backer rod material was placed into the joints to provide the proper depth to width ratio or shape factor. For most of the sealants used on the project the proper shape factor is approximately one; therefore, the backer rod was inserted to a depth of approximately 1 in. The 1-in. depth allows for a 1/8 to 1/4 in. recess below the pavement surface and approximately 3/4 in. of sealant material. The silicone sealants require a shape factor of approximately 1/2; therefore, the backer rod was inserted to a depth of approximately 3/4 in. The 3/4-in. depth allows for a 1/8- to 1/4-in. recess below the pavement surface and approximately 1/2 in. of sealant material. The flush fill geometry was achieved by slightly overfilling the joint and

then using a squeegee to level off the excess sealant. A 3 to 4 in. band was formed over the joint using this technique. All of one sealant was installed before cleaning out the melter and heating another sealant. This procedure expedited the sealing operation and minimized waste.

Most of the joints which were sealed during this project had some of spalling. None of the spalls were repaired before the joints were sealed. Also, during the installation of the sealant materials, the manufacturers noted that small amounts of the old joint sealant were left in the joints. The manufacturers wanted the residual sealant removed to prevent potential incompatibility problems and to prevent adhesion failures at those areas. The manufacturers were asked to mark the location of the residual sealant to ensure these areas could be delineated in future evaluations, but the residual sealant was not removed. Table 2 provides a summary of the various sealant materials that were installed, conditions experienced during joint preparation and sealant installation, and any sealant reactions that occurred during or immediately after installation.

Table 2
Joint Sealant Installation Summary

Installation Date	Weather Conditions	Area/ Section	Sealant Material	Application Observations
06/12/91	Low temperatures were in the low 40's, Highs were in the low to mid 60's. Was windy and overcast. Had a very light rain at noon. The misting lasted about 30 min.	1/1 1/2[1] 1/3[2] 1/18 1/19[1] 1/20[2]	Crafco RoadSaver 222	A small portion of the sealant material was placed in the melter at approximately 4:00 a.m. so that it could be turned on and warmed up. The remainder of the sealant was placed in the melter at approximately 8:00 a.m. and the temperature of the melter was brought to 400°F for sealant application. Section 1 was sealed at approximately 11:30 a.m., followed by Section 2, Section 18, Section 19, Section 20, and Section 3. Sealing of these sections was completed at approximately 1:30 p.m. Sections 3 and 20 were primed at approximately 11:00 a.m. Therefore, the primer was allowed to cure for over 1 hr before the sealant was installed. All of these sections exhibited surface bubbling during the installation of the sealant. The primed sections (3 and 20) appeared to have less bubbling than the unprimed sections and the flush fill geometry sections (2 and 19) appeared to have the most bubbling.
06/12/91	Same as above.	1/4 1/5[1] 1/6[2] 1/21 1/22[1] 1/23[2]	Crafco Improved Non-JFR Sealant	All of these sections were poured in the afternoon. The melter was cleaned to remove all RoadSaver 222 material and the improved material was placed in the melter. The temperature of the melter was brought to approximately 380°F for sealant application. The primer placed in Sections 6 and 23 was allowed to cure for over 1 hr before the sealant was installed. All of sections exhibited some surface bubbling, but the bubbling appeared to be less than exhibited in the RoadSaver 222. All sections had approximately the same amount of bubbling. Crafco RoadSaver Silicone sealant was placed in Section 23 by accident. Therefore, the remainder of the sealant that as supposed to be placed in Section 23 was placed in Section 24.

(Sheet 1 of 3)

[1] Flush fill geometry used.
[2] All or selected joints were primed.

Table 2 (Continued)

Installation Date	Weather Conditions	Area/ Section	Sealant Material	Application Observations
06/12/91	Same as above.	1/7 1/24	Crafco RoadSaver Silicone SL Sealant	These sections were sealed by hand using caulking tubes. Some of the sealant that was supposed to be placed in Section 24 was placed in Section 23 by accident. Both of these sections were sealed in the afternoon.
06/13/91	The low was in the low to mid 40's. The high was in the low 60's. It did not rain, but it was windy.	1/8 1/16	Mobay Baysilone 960	These sections were sealed using an extrusion pump. The manufacturer noted that some old sealant material had been left in isolated areas. These areas were not recleaned to remove the residual material.
06/13/91	Same as above	1/9 1/15	Mobay Baysilone 960 Self-Leveling	These sections were sealed using an extrusion pump. Some old sealant material was also left in some isolated areas. The residual material was not removed from the joints. The Baysilone 960 Self-Leveling material that came in contact with residual sealant experienced discoloring.
06/13/91	Same as above.	1/10[2] 1/17[1]	Koch Product 9005	Some old joint sealant material was left in isolated areas of the joints. The residual material was not removed from the joints. A Koch primer material was applied to selected joints in both sections. The primer was allowed to cure for a minimum of 1 hr before sealing. The sealant experienced some surface bubbling during installation in both the primed and unprimed joints.
06/12/91	Same as above.	1/11 1/14	Dow Corning 902 RCS	These sections were sealed using a pressurized caulking gun. Some of the joints in both of these sections were sealed with Dow Corning 890 SL due to a lack of material.
06/12/91	Same as above.	1/12 1/13	Dow Corning 890 SL	These sections were sealed using an extrusion pump.

(Sheet 2 of 3)

Table 2 (Concluded)

Installation Date	Weather Conditions	Area/ Section	Sealant Material	Application Observations
06/14/91	The low was in the high 40's and the high was in the low to mid 60's. There was a gusty wind, but no rain.	2/1 2/6	Crafco Superseal 1614A	These sections were sealed in the morning. The sealant exhibited surface bubbling in both sections.
06/14/91	Same as above.	2/2 2/7	Crafco Improved JFR	The sealant exhibited surface bubbling in both sections, but it was less than that exhibited by the Superseal 1614A.
06/13/91	Same as above.	2/3 2/9	Koch Product 9050 SL	The sections were sealed using an extrusion pump.
06/13/91 06/14/91	Same as above.	2/4 2/10	Koch Product 9020	Approximately half of the joints in Section 10 were sealed on 06/13. The remaining joints of Section 10 were sealed on 06/14. Crafco Superseal 1614A was used to seal one joint in Section 4 due to a lack of Product 9020. The manufacturer had some difficulty mixing the Product 9020 because of the cool weather. The cans of sealant had to be warmed before satisfactory mixing and application could be achieved.
06/14/91	Same as above.	2/5[2] 2/8[2]	Koch Product 9012	Selected joints in both sections were primed. Sealant exhibited some surface bubbling during installation.

(Sheet 3 of 3)

5 Field Evaluation

Six Month Field Evaluations

The 6-month field evaluations were conducted on 22 January 1992. Snow had to be removed from both areas before the sealant could be evaluated. Area 2 was surveyed during the morning. The weather during the Area 2 survey was cloudy and windy with an ambient temperature of 25°F. Area 1 was surveyed during the afternoon. The weather during the Area 1 survey was cloudy with a slight breeze and an ambient temperature of 35°F.

The evaluation of each sealant material was conducted by visually inspecting the material for defects. If any defects were noted, the type of defect was described and the quantity of that defect was measured. The quantity of the defect was divided by the total quantity of sealant and the result reported as percent defect. Adhesion and cohesion failure, fuel damage and debris retention were the main defects that were anticipated, but items such as discoloration, bubbling, and surface cracking were also plausible. The percent defect was subdivided into five categories:

a. 0 percent - no failure.

b. < 11 percent - few failure.

c. 11 - 50 percent - frequent failure.

d. > 50 percent - extensive failure.

e. 100 percent - complete failure.

The most common defect noted with the hot-applied sealant materials both non-JFR and JFR was bubbling. Many of the hot-applied sealants experienced surface bubbling during installation, and the bubbling had appeared to increase both in size and quantity as the sealants aged. The primer material developed during the CHAR project did not appear to reduce the bubbling tendencies of the hot-applied sealants and in some cases it appeared to increase the bubbling tendency. Problems noted during the installation of the primer and sealant material concerning the curing of the primer may explain why the primer did not reduce the bubbling. A separate investigation was conducted to determine

if the primer had not properly cured. The investigation is discussed later in this report.

A small amount of adhesion failures was observed in the sealant materials. All of the failures were less than 1 percent and were classified as few. Some of the adhesion failures noted in the flush fill geometry appeared to have been caused by snow plows. The exact cause of the other adhesion failures was not determined.

A coin test was conducted on each of the sealants in addition to the visual evaluation. The coin test was conducted by pressing the edge of a quarter into the sealant material to a depth of approximately 1/4 in. The quarter was then released and the sealant was allowed to rebound. The results of the test were reported as retained or rejected the coin. If the sealant rejected the coin, it was considered to be satisfactorily resilient. If the sealant retained the coin, it was considered not to be resilient. Generally, the cold-applied sealants rejected the coin and the hot-applied sealants retained the coin. The information and data collected during the 6-month evaluation are provided in Figures 5 through 38, and a summary of the data is provided in Table 3.

One Year Field Evaluations

The 1-year evaluations were conducted during the morning of 27 July 1992. The ambient temperature during the evaluations ranged from 68 to 75°F. The same evaluation criteria used during the 6-month evaluations were used for the 1-year evaluations. Because of the large amount of bubbling that was evident during the 6-month evaluation, a rating system was used to allow a quantitative comparison between the various sealants. The numeric rating system was developed by Crafco, Incorporated during the additional bubble study to evaluate the effectiveness of the primer system. The rating system was based on three items; number of bubbles per foot, bubble size, and sealant swelling. The rating system is provided in Table 4. The overall rating is determined by adding the individual ratings and dividing by 3.

The 1-year evaluations did not differ greatly from the 6-month evaluations. The most common defect noted with the hot-applied sealants was bubbling, and a small amount of adhesion failure was evident. The adhesion failures were still less than 1 percent and were classified as few. The coin test was conducted on each of the sealants, and almost all of the sealants, with the exception of the hot-applied, asphalt-based materials, rejected the coin. The information and data collected during the 1-year evaluation are provided in Figures 39 through 72, and a summary of the data is provided in Table 5.

Table 3
Six Month Joint Sealant Field Evaluation Summary

Area/ Section	Sealant Material	Sealant Discoloration	Surface Cracking	Bubbling	Coin Test	Adhesion Failure[1]	Cohesion Failure[1]	Fuel Damage[1]	Debris Retention[1]
1/1	Crafco RoadSaver 222	None	Yes	Yes	Retained	None	None	None	None
1/2[2]	Crafco RoadSaver 222	None	None	Yes	Retained	None	None	None	None
1/3[3]	Crafco RoadSaver 222	None	None	Yes	Retained	None	None	None	None
1/4	Crafco Improved Non-JFR	None	None	Yes	Retained	None	None	None	None
1/5[2]	Crafco Improved Non-JFR	None	None	Yes	Retained	Few	None	None	None
1/6[3]	Crafco Improved Non-JFR	None	None	Yes	Retained	Few	None	None	None
1/7	Crafco RoadSaver Silicone SL	None	None	None	Rejected	None	None	None	None
1/8	Mobay Baysilone 960	Yes	None	None	Rejected	Few	None	None	None
1/9	Mobay Baysilone 960 SL	Yes	None	None	Rejected	None	None	None	None
1/10[3]	Koch Product 9005	None	None	Yes	Retained	Few	None	None	None
1/11	Dow Corning 902 RCS	None	None	None	Rejected	None	None	None	None
1/12	Dow Corning 890 SL	None	None	None	Rejected	Few	None	None	None
1/13	Dow Corning 890 SL	None	None	None	Rejected	None	None	None	None
1/14	Dow Corning 902 RCS	None	None	None	Rejected	Few	None	None	None
1/15	Mobay Baysilone 960 SL	Yes	None	None	Rejected	None	None	None	None

(Continued)

[1] Definition of results provided on evaluation sheets.
[2] Flush fill geometry used.
[3] Primer material used in section.

Table 3 (Concluded)

Area/ Section	Sealant Material	Sealant Discoloration	Surface Cracking	Bubbling	Coin Test	Adhesion Failure[1]	Cohesion Failure[1]	Fuel Damage[1]	Debris Retention[1]
1/16	Mobay Baysilone 960	Yes	None	None	Rejected	None	None	None	None
1/17[3]	Koch Product 9005	None	Yes	Yes	Retained	Few	None	None	None
1/18	Crafco RoadSaver 222	None	Yes	Yes	Rejected	None	None	None	None
1/19[2]	Crafco RoadSaver 222	None	None	Yes	Retained	None	None	None	None
1/20[3]	Crafco RoadSaver 222	None	None	Yes	Retained	None	None	None	None
1/21	Crafco Improved Non-JFR	None	None	Yes	Retained	None	None	None	None
1/22[2]	Crafco Improved Non-JFR	None	None	Yes	Retained	None	None	None	None
1/23[3]	Crafco Improved Non-JFR	None	None	Yes	Retained	None	None	None	None
1/24	Crafco RoadSaver Silicone SL	None	None	None	Rejected	None	None	None	None
2/1	Crafco Superseal 1614A	None	Yes	None	Retained	None	None	None	None
2/2	Crafco Improved JFR	None	Yes	Yes	Retained	None	None	None	None
2/3	Koch Product 9050 SL	None	None	None	Rejected	None	None	None	None
2/4	Koch Product 9020	None	Yes	None	Rejected	Few	None	None	None
2/5[3]	Koch Product 9012	None	None	Yes	Rejected	None	None	None	None
2/6	Crafco Superseal 1614A	None	Yes	None	Retained	Few	None	None	None
2/7	Crafco Improved JFR	None	None	None	Rejected	None	None	None	None
2/8[3]	Koch Product 9012	None	Yes	Yes	N/A	None	None	None	None
2/9	Koch Product 9050 SL	None	Yes	None	Retained	None	None	None	None
2/10	Koch Product 9020	None	None	None	Rejected	None	None	None	None

Table 4
Sealant Bubbling Rating System

Item	Rating			
	0	1	2	3
Number of Bubbles per Foot of Joint	None	1-5	5-15	16 +
Size of Bubbles	None	1/8 in.	1/8 in.-1/4 in.	> 1/4 in.
Sealant Swelling	None	1/8 in.	1/8 in.-1/4 in.	> 1/4 in.

Additional Bubble Study[1]

A 14 ft wide by 64 ft long by 6 in. deep concrete test slab was constructed at Crafco Incorporated in August 1991. The slab was constructed of standard PCC as specified for use in concrete pavement construction by the Arizona Department of Transportation. The slab was coated with a curing membrane after placement. The initial saw cuts, 1/8 in. by 2 in., were made within the first 24 hr. The joint sealant reservoir was formed after the concrete had cured for 48 hr. The final dimensions of the joints were 1/2 in. wide by 2 in. deep. After the sawing operation had been completed, the joints were washed with water, allowed to dry, and then sandblasted. A total of 48 test joints were formed into the slab by sawing six longitudinal and seven transverse joints. The test joint layout for the bubble study and the numbering system used to identify the test joints is shown on Figure 73.

The controlled variables for the study were the type of sealant installed, primed or unprimed joints, and the age of the slab when the sealant material was installed. Table 6 lists the materials installed and the conditions under which they were installed. Two replicate joints for each sealant, primer, and slab age combination were poured. The joints used for each combination were selected at random. The primer used in the joints was pilot production sample RS-12. Additionally, the ambient temperature and humidity conditions were monitored three times daily as were the sealant and slab surface temperature. The weather data are provided in Table 7. Additional information on the material properties of selected sealants can be found in Lynch et al. 1993.

Twenty to 24 hr before the sealant was installed into the joint, the section was wetted with water from a hand held sprayer. This was done to simulate sealing projects where the sawing operations are conducted on the previous day. The joints were allowed to air dry overnight and then the primer was applied to the appropriate joints approximately 3 hr before sealing. The primer was allowed to dry to a tack free condition as determined by touching. A 5/8 in. polyethylene backer rod, HBR XL, was installed into the joints to a

[1] Test data for the additional bubble study was provided by Crafco Incorporated.

Table 5
One Year Joint Sealant Field Evaluation Summary

Area/ Section	Sealant Material	Sealant Discoloration	Surface Cracking	Bubbling (Rating)[1]	Coin Test	Adhesion Failure[2]	Cohesion Failure[2]	Fuel Damage[2]	Debris Retention[2]
1/1	Crafco RoadSaver 222	None	Yes	Yes (0.7)	Retained	Few	None	None	None
1/2[3]	Crafco RoadSaver 222	None	None	Yes (2.3)	Retained	None	None	None	None
1/3[4]	Crafco RoadSaver 222	None	None	Yes (2.3)	Retained	None[5]	None	None	None
1/4	Crafco Improved Non-JFR	None	Yes	Yes (2.0)	Retained	None[5]	None	None	None
1/5[3]	Crafco Improved Non-JFR	None	Yes	Yes (2.0)	Retained	Few	None	None	None
1/6[4]	Crafco Improved Non-JFR	None	None	Yes (2.7)	Retained	Few	None	None	None
1/7	Crafco RoadSaver Silicone SL	None	None	None	Rejected	None	None	None	None
1/8	Mobay Bays.lone 960	Yes	None	None	Rejected	Few	None	None	None
1/9	Mobay Baysilone 960 SL	Yes	None	Yes (1.3)	Rejected	None	None	None	None
1/10[4]	Koch Product 9005	None	Yes	Yes (1.3)	Retained	Few	None	None	None
1/11	Dow Corning 902 RCS	Yes	None	None	Rejected	None	None	None	None
1/12	Dow Corning 890 SL	None	None	None	Rejected	Few	None	None	None
1/13	Dow Corning 890 SL	Yes	None	None	Rejected	None	None	None	None
1/14	Dow Corning 902 RCS	Yes	None	Yes (0.7)	Rejected	Few	None	None	None

(Continued)

[1] See pages 16 and 18 for rating definition. Example: number of bubbles, 1; size of bubbles, 1; swelling, 0. Add 3 together = 2 divided by 3 (factors) equals a rating of 0.67 or 0.7.
[2] Definition of results provided on evaluation sheets.
[3] Flush fill geometry used.
[4] Primer material used in section.
[5] Sealant pulling away from joint face at the pavement surface. Typical depth of "failure" 1/16 to 1/8 in.

Table 5 (Concluded)

Area/ Section	Sealant Material	Sealant Discoloration	Surface Cracking	Bubbling (Rating)[1]	Coin Test	Adhesion Failure[2]	Cohesion Failure[2]	Fuel Damage[2]	Debris Retention[2]
1/15	Mobay Baysilone 960 SL	Yes	None	None	Rejected	None	None	None	None
1/16	Mobay Baysilone 960	Yes	None	None	Rejected	Few	None	None	None
1/17[4]	Koch Product 9005	None	Yes	Yes (2.0)	Retained	None[5]	None	None	None
1/18	Crafco RoadSaver 222	None	Yes	Yes (1.3)	Rejected	None[5]	None	None	None
1/19[3]	Crafco RoadSaver 222	None	Yes	Yes (2.0)	Retained	None	None	None	None
1/20[4]	Crafco RoadSaver 222	None	Yes	Yes (1.0)	Retained	None[5]	None	None	None
1/21	Crafco Improved Non-JFR	None	Yes	Yes (1.0)	Retained	None[5]	None	None	None
1/22[3]	Crafco Improved Non-JFR	None	Yes	Yes (1.3)	Retained	None[5]	None	None	None
1/23[4]	Crafco Improved Non-JFR	None	None	Yes (1.0)	Retained	None[5]	None	None	None
1/24	Crafco RoadSaver Silicone SL	None	None	None	Rejected	None	None	None	None
2/1	Crafco Superseal 1614A	None	Yes	Yes (0.7)	Rejected	None[5]	None	None	None
2/2	Crafco Improved JFR	Yes	Yes	Yes (0.7)	Rejected	None	None	None	None
2/3	Koch Product 9050 SL	None	Yes	None	Rejected	None	None	None	None
2/4	Koch Product 9020	None	Yes	None	Rejected	Few	None	None	None
2/5[4]	Koch Product 9012	None	None	Yes (1.0)	Rejected	None[5]	None	None	None
2/6	Crafco Superseal 1614A	None	Yes	Yes (0.7)	Rejected	None[5]	None	None	None
2/7	Crafco Improved JFR	Yes	Yes	None	Rejected	None	None	None	None
2/8[4]	Koch Product 9012	None	Yes	Yes (0.7)	Rejected	None[5]	None	None	None
2/9	Koch Product 9050 SL	None	Yes	None	Rejected	Few	None	None	None
2/10	Koch Product 9020	None	None	None	Rejected	Few	None	None	None

Table 6
Sealant Installation Plan

Sealant Material	Replicate	Slab Age (in days)[1]			
		5	8	14	30
Crafco RoadSaver 222 (unprimed joints)	1	2-4	4-5	5-5	5-6
	2	3-8	1-1	3-1	5-8
Crafco RoadSaver 222 (primed joints)	1	1-3	3-7	2-5	6-7
	2	6-8	1-6	6-2	1-8
Crafco Improved Non-JFR (unprimed joints)	1	6-6	2-6	4-3	5-3
	2	5-1	4-2	2-8	4-8
Crafco Improved Non-JFR (primed joints)	1	6-3	5-7	1-5	3-3
	2	4-1	3-5	3-4	2-2
Crafco Superseal 1614A (unprimed joints)	1	4-6	3-6	5-2	4-7
	2	1-4	6-4	2-1	1-2
Crafco Improved JFR (unprimed joints)	1	1-7	2-7	4-4	5-4
	2	6-1	6-5	3-2	2-3

[1] The first number refers to the longitudinal joint from 1 to 6, and the second number refers to the section number from 1 to 8.

depth of 1 in. below the pavement surface. The sealant was heated in a 1-gal container to a temperature between the pouring temperature and safe heating temperature in the laboratory. The sealant was then carried to the slab and poured into the joint. The sealant temperature was monitored, and installation into the joint was completed before the temperature fell below the pouring temperature. The sealant materials were installed with a recess of approximately 1/4 in. below the pavement surface.

After installation, the appearance of the sealants was evaluated. Specific items of interest included the quantity and size of bubbles that formed, any swelling of the sealant, and the general overall appearance of the sealant surface.

Each of the sealants were evaluated immediately after installation into the joint and then at specified intervals over a 3 month period. The ratings for each of the items was determined during the evaluation, averaged, and reported as the overall rating. Tables 8 through 11 list the data collected from these evaluations including the date each material was installed, the dates of each evaluation, and the average rating at the evaluation date. The three numbers separated by commas in the evaluation column represent the rating for the number of bubbles per foot of joint, size of bubbles, and sealant swelling, respectively.

Table 7
Weather Data at Test Slab

Date	Time	Air Temp. (F)	Sealant Temp. (F)	Slab Temp. (F)	Humidity (%)	Weather Condition
8/6/91	8	88				S
	11	97		130		S
	2	105	123	130		S
8/7/91	8	83	97	91	27	S
	11	95	125	128	14	S
	2	105	129	136	11	S
8/8/91	8	83	130	99	32	S
	11	97	127	130	21	S
	2	107	134	142	20	S
8/9/91	8	90	94	94	37	C
	11	97	109	118	29	C
	2	99	110	119	28	C
8/12/91	8	81	84	90	64	P.C.
	11	98	118	131	34	S
	2	98	118	131	34	S
8/13/91	8	81	96	105	49	S
	11	95	120	12[illegible]	33	S
	2	103	124	13[illegible]	23	S
8/14/91	8	86	9[illegible]	9[illegible]	42	C
	11	94	106	115	32	P.C.
	2	101	122	135	28	S
8/15/91	8	86	96	106	51	P.C.
	11	93	110	127	29	P.C.
	2	101	124	134	28	P.C.
8/16/91	8	84	98	100	45	P.C.
	11	91	100	108	40	P.C.
	2	100	112	135	25	S
8/19/91	8	80	88	95	44	P.C.
	11	97	118	130	21	P.C.
	2	102	125	133	19	P.C.
8/20/91	8	81	90	99	51	S
	11	95	122	130	28	S
	2	103	132	144	21	S

(Continued)

Notes:
Weather: S = Sunny C = Cloudy R = Rain P.C. = Partly Cloudy
Time: 8 = 8:00 a.m. 11 = 11:00 a.m. 2 = 2:00 p.m.
Humidity is measured at the slab using a sling psychrometer.

Table 7 (Concluded)

Date	Time	Air Temp. (F)	Sealant Temp. (F)	Slab Temp. (F)	Humidity (%)	Weather Condition
8/21/91	8	88	92	93	38	C
	11	92	98	100	33	C
	2	101	122	130	22	P.C.
8/22/91	8	87	98	102	49	P.C.
	11	98	126	135	32	P.C.
	2	102	131	140	26	S
8/23/91	8	86	96	98	42	P.C.
	11	97	118	128	27	P.C.
	2	100	126	134	25	P.C.
8/26/91	8					
	11	96	122	134	33	S
	2	102	132	148	31	S
8/27/91	8	76	80	75	8[illegible]	R
	11	81	87	89	72	C
	2	86	96	100	57	C
8/28/91	8	80	84	90	68	S
	11	93	118	100	38	S
	2	97	124	134	32	S
8/29/91	8	82	92	98	49	S
	11	94	116	124	32	S
	2	103	128	142	16	S
8/30/91	8	85	96	104	47	S
	11	98	120	134	13	S
	2	105	124	139	18	P.C.
9/3/91	8	83	96	88	59	S
	11	92	124	124	43	S
	2	99	132	132	33	S
9/4/91	8					
	11					
	2	102	130	134	24	S
9/5/91	8	83	94	96	32	P.C.
	11	90	100	105	34	C
	2	74	80	68	91	R
9/6/91	8					
	11	82	106	110	62	S
	2	89	118	128	41	S

The data indicate that the amount of bubbling which occurred in the non-JFR materials, Crafco RoadSaver 222 and Crafco Improved 1401 inconsistently varied depending upon the length of time that the slab had cured before sealant placement. The data also indicate that the primer application reduced the amount of initial bubbling by 14 percent for the RoadSaver 222 and 25 percent for the Improved 1401, but by the end of the test period both the primed and unprimed sections had similar overall bubble ratings. Visual observations of the primed and unprimed sections indicated that the primed sections experienced fewer and smaller bubbles, but exhibited an increase in swelling. Table 12 provides summarized bubble data for the four sealants. It is possible that the primer was not completely cured when the sealant was installed. Therefore, the swelling could have been caused by the release of solvent from the primer or the fact that the temperature during the additional study was significantly higher than the temperature during the application at Fairchild AFB. Additional work will be required on the primer formulation or application procedures before requiring it on joint sealing projects.

Table 8
Joint Bubble Condition Rating for Sealants Installed After 5 Days of Slab Curing. Installation Date was 8/6/91

Sealant	Date	Primed					Unprimed				
		Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg	Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg
		Rating	Avg.	Rating	Avg.		Rating	Avg.	Rating	Avg.	
Crafco RoadSaver 222	8/6	0,0,0	0.00	0,0,0	0.00	0.00	1,1,1	1.00	1,1,1	1.00	1.00
	8/7	1,1,1	1.00	1,1,1	1.00	1.00	1,1,1	1.00	1,1,1	1.00	1.00
	8/9	1,1,1	1.00	1,1,1	1.00	1.00	2,1,1	1.33	1,1,1	1.00	1.17
	8/12	1,1,1	1.00	1,1,1	1.00	1.00	2,1,1	1.33	1,1,1	1.00	1.17
	8/15	1,1,1	1.00	1,1,1	1.00	1.00	2,1,1	1.33	1,1,1	1.00	1.17
	9/13	1,1,1	1.00	1,1,1	1.00	1.00	2,1,1	1.33	1,1,1	1.00	1.17
	9/26	2,2,1	1.67	1,1,1	1.00	1.34	2,1,1	1.33	1,1,1	1.00	1.17
	10/21	2,2,1	1.67	1,1,1	1.00	1.34	2,1,1	1.33	1,1,1	1.00	1.17
Crafco Improved Non-JFR	8/6	1,1,1	1.00	0,0,0	0.00	0.50	2,1,1	1.33	3,1,1	1.67	1.50
	8/7	1,1,1	1.00	1,1,1	1.00	1.00	2,1,1	1.33	3,2,1	2.00	1.67
	8/9	1,1,1	1.00	2,2,1	1.67	1.34	2,1,1	1.33	3,2,1	2.00	1.67
	8/12	1,2,2	1.67	2,2,1	1.67	1.67	2,2,1	1.67	3,2,1	2.00	1.84
	8/15	1,2,2	1.67	2,2,2	2.00	1.84	2,2,1	1.67	3,2,1	2.00	1.84
	9/13	1,2,2	1.67	2,2,2	2.00	1.84	2,2,1	1.67	3,2,1	2.00	1.84
	9/26	1,2,2	1.67	2,2,2	2.00	1.84	2,2,1	1.67	3,2,1	2.00	1.84
	10/21	1,2,2	1.67	2,2,2	2.00	1.84	2,2,1	1.67	3,2,1	1.67	1.84

(Continued)

Note: Primer is a spray application of Primer RS-12.

Table 8 (Concluded)

Sealant	Date	Primed					Unprimed				
		Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg	Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg
		Rating	Avg.	Rating	Avg.		Rating	Avg.	Rating	Avg.	
Crafco Superseal 1614A	8/6						2,1,0	1.00	3,2,0	2.00	1.34
	8/7						3,2,0	1.67	3,3,0	2.00	1.84
	8/9						3,2,0	1.67	3,3,0	2.00	1.84
	8/12						3,2,0	1.67	3,3,0	2.00	1.84
	8/15						3,2,0	1.67	3,3,0	2.00	1.84
	9/13						3,2,0	1.67	3,3,0	2.00	1.84
	9/26						3,2,0	1.67	3,3,0	2.00	1.84
	10/21						3,2,0	1.67	3,3,0	1.00	1.84
Crafco Improved JFR	8/6						2,1,0	1.00	2,1,0	1.00	1.00
	8/7						2,2,0	1.33	2,1,0	1.33	1.17
	8/9						2,2,0	1.33	2,2,0	1.33	1.33
	8/12						2,2,0	1.33	2,2,0	1.33	1.33
	8/15						2,2,0	1.33	2,2,0	1.33	1.33
	9/13						2,2,0	1.33	2,2,0	1.33	1.33
	9/26						2,2,0	1.33	2,0,0	1.33	1.33
	10/21						2,2,0	1.33	2,2,0	1.33	1.33

Table 9
Joint Bubble Condition Rating for Sealants Installed After 8 Days of Slab Curing. Installation Date was 8/9/91

Sealant	Date	Primed					Unprimed				
		Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg.	Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg.
		Evaluation	Avg.	Evaluation	Avg.		Evaluation	Avg.	Evaluation	Avg.	
Crafco RoadSaver 222	8/12	2,1,1	1.33	2,1,1	1.33	1.33	1,1,0	0.67	1,1,1	1.00	0.84
	8/15	2,1,1	1.33	2,2,1	1.67	1.50	1,2,0	1.00	2,1,1	1.33	1.17
	9/13	2,2,2	2.00	2,2,1	1.67	1.84	2,2,0	1.33	2,2,1	1.67	1.50
	9/26	2,2,2	2.00	2,2,2	2.00	2.00	2,2,1	1.67	3,2,1	2.00	1.84
	10/21	2,2,2	2.00	2,2,2	2.00	2.00	2,2,1	1.67	3,2,1	2.00	1.84
Crafco Improved Non-JFR[1]	8/12	2,1,1	1.33	2,1,1	1.33	1.33	2,1,1	1.33	1,2,1	1.33	1.33
	8/15	2,1,1	1.33	2,1,1	1.33	1.33	2,1,1	1.33	2,2,1	1.67	1.50
	9/13	2,2,2	2.00	2,2,2	2.00	2.00	2,2,1	1.67	3,2,2	2.33	2.00
	9/26	2,2,2	2.00	2,2,3	2.33	2.17	2,2,1	1.67	3,2,2	2.33	2.00
	10/21	2,2,2	2.00	2,2,3	2.33	2.17	2,2,1	1.67	3,2,2	2.33	2.00
Crafco Superseal 1614A	8/12						1,2,0	1.00	1,2,0	1.00	1.00
	8/15						1,2,0	1.00	1,2,0	1.00	1.00
	9/13						1,2,0	1.00	1,2,0	1.00	1.00
	9/26						1,2,0	1.00	1,2,0	1.00	1.00
	10/21						1,2,0	1.00	1,2,0	1.00	1.00
Crafco Improved JFR	8/12						1,1,0	0.67	1,1,0	0.67	0.67
	8/15						1,1,0	0.67	1,1,0	0.67	0.67
	9/13						1,1,0	0.67	1,1,0	0.67	0.67
	9/26						1,1,0	0.67	1,1,0	0.67	0.67
	10/21						1,1,0	0.67	1,1,0	0.67	0.67

[1] The primer might not have been 100 percent dry at time of pour.

Table 10
Joint Bubble Condition Rating for Sealants Installed After 14 Days of Slab Curing. Installation Date was 8/15/91

Sealant	Date	Primed					Unprimed				
		Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg.	Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg.
		Evaluation	Avg.	Evaluation	Avg.		Evaluation	Avg.	Evaluation	Avg.	
Crafco RoadSaver 222	8/19	1,1,1	1.00	1,1,1	1.00	1.00	2,2,1	1.67	3,2,1	2.00	1.84
	8/22	1,1,1	1.00	1,1,1	1.00	1.00	2,2,1	1.67	3,2,1	2.00	1.84
	8/27	1,1,1	1.00	1,2,1	1.33	1.17	2,2,1	1.67	3,2,1	2.00	1.84
	9/13	2,2,1	1.67	1,2,1	1.33	1.50	2,2,1	1.67	3,2,1	2.00	1.84
	9/26	2,2,1	1.67	1,2,2	1.67	1.67	2,2,1	1.67	3,2,1	2.00	1.84
	10/21	2,2,2	2.00	1,2,2	1.67	1.84	2,2,1	1.67	3,2,1	2.00	1.84
Crafco Improved Non-JFR	8/19	1,2,1	1.33	1,2,1	1.33	1.33	3,2,1	2.00	3,2,1	2.00	2.00
	8/22	1,2,1	1.33	1,2,2	1.67	1.50	3,2,1	2.00	3,2,1	2.00	2.00
	8/27	2,2,1	1.67	2,2,3	2.33	2.00	3,2,1	2.00	3,2,1	2.00	2.00
	9/13	2,2,1	1.67	2,2,3	2.33	2.00	3,2,1	2.00	3,2,1	2.00	2.00
	9/26	2,2,1	1.67	2,2,3	2.33	2.00	3,3,1	2.33	3,2,1	2.00	2.17
	10/21	2,2,1	1.67	2,2,3	2.33	2.00	3,3,1	2.33	3,2,1	2.00	2.17
Crafco Superseal 1614A	8/19						1,2,0	1.00	1,2,0	1.00	1.00
	8/22						1,2,0	1.00	1,2,0	1.00	1.00
	8/27						1,2,0	1.00	1,2,0	1.00	1.00
	9/13						1,2,0	1.00	1,2,0	1.00	1.00
	9/26						1,2,0	1.00	1,2,0	1.00	1.00
	10/21						1,2,0	1.00	1,2,0	1.00	1.00
Crafco Improved JFR	8/19						0,1,0	0.33	0,1,0	0.33	0.33
	8/22						0,1,0	0.33	0,1,0	0.33	0.33
	8/27						0,1,0	0.33	0,1,0	0.33	0.33
	9/13						0,1,0	0.00	0,1,0	0.33	0.33
	9/26						0,1,0	0.33	0,1,0	0.33	0.33
	10/21						0,1,0	0.33	0,1,0	0.33	0.33

Table 11
Joint Bubble Condition Rating for Sealants Installed After 30 Days of Slab Curing. Installation Date was 8/30/91

Sealant	Date	Primed					Unprimed				
		Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg.	Rep. 1		Rep. 2		Rep. 1, Rep. 2 Avg.
		Evaluation	Avg.	Evaluation	Avg.		Evaluation	Avg.	Evaluation	Avg.	
Crafco RoadSaver 222	9/3	1,1,0	0.67	1,1,1	1.00	0.84	1,1,1	1.00	1,1,1	1.00	1.00
	9/13	1,2,1	1.33	1,2,1	1.33	1.33	2,2,1	1.67	2,2,1	1.67	1.67
	9/26	2,2,1	1.67	1,2,1	1.50	1.50	2,2,1	1.67	2,2,1	1.67	1.67
	10/21	2,2,1	1.67	1,2,1	1.50	1.50	2,2,1	1.67	2,2,1	1.67	1.67
Crafco Improved Non-JFR	9/3	1,1,1	1.00	0,0,0	0.00	0.50	1,1,1	1.00	1,1,1	1.00	1.00
	9/13	1,1,1	1.00	1,2,1	1.33	1.17	3,2,1	2.00	1,2,1	1.33	1.67
	9/26	1,3,1	1.67	1,2,2	1.67	1.67	3,3,2	2.67	2,2,1	1.67	2.17
	10/21	1,3,1	1.67	1,2,2	1.67	1.67	3,3,2	2.67	2,2,1	1.67	2.17
Crafco Superseal 1614A	9/3						2,2,0	1.33	1,2,0	1.00	1.17
	9/13						2,2,0	1.33	2,2,0	1.33	1.33
	9/26						2,2,0	1.33	2,2,0	1.33	1.33
	10/21						2,2,0	1.33	2,2,0	1.33	1.33
Crafco Improved JFR	9/3						2,2,0	1.33	2,2,0	1.33	1.33
	9/13						2,2,0	1.33	2,2,0	1.33	1.33
	9/26						2,2,0	1.33	2,2,0	1.33	1.33
	10/21						2,2,0	1.33	2,2,0	1.33	1.33

Table 12
Initial Bubble Rating Versus Final Bubble Rating

Sealant Material	Rating		Percent Change
	After 3 days	At 10/21/91	
Crafco RoadSaver 222 (unprimed joints)	1.21	1.63	+34.7
Crafco RoadSaver 222 (primed joints)	1.04	1.67	+60.6
Crafco Improved 1401 (unprimed joints)	1.50	2.05	+36.7
Crafco Improved Non-JFR (primed joints)	1.12	1.92	+71.4
Crafco Superseal 1614A (unprimed joints)	1.25	1.29	+3.2
Crafco Improved JFR (unprimed joints)	0.91	0.91	0.0

6 Conclusions and Recommendations

The objectives of the overall project were to develop specification limits for hot-applied non-JFR and JFR sealants that would exhibit improved performance characteristics over currently used materials, develop a primer system that would minimize the bubbling tendencies of hot-applied sealants and improve the sealant's adhesion to PCC, and to determine if a flush fill geometry would provide increased performance life versus the current practice of recessing the sealant 1/8 to 1/4 in. below the pavement surface. The specific objective of the field evaluation phase of the project was to obtain actual field data to determine if the overall objectives had been met.

During the sealant installation at Fairchild AFB, WA, it was very apparent that the joint sealant manufacturers prefer joints that are hospital clean when their materials are being evaluated. This preference was demonstrated when two of the manufacturers requested that residual sealant be removed from the joints before their sealant was installed. They apparently believe that better field performance can be obtained when the joints are perfectly clean. Based on this information, the guidance provided in the U.S. Army Corps of Engineers Guide Specifications concerning joint preparation and joint cleanliness should not be changed.

The primer system that was developed to minimize the bubbling tendencies of hot-applied sealants should not be incorporated into project specifications at this time. The primer appeared to reduce initial bubbling but this advantage was negated within 2 months after sealant installation. Additional work was conducted by Crafco to eliminate potential swelling problems created by solvent release from the primer and to determine if the initial reduction in bubbling can be extended to long term performance.

None of the sealant materials exhibited failure after the 6-month and 1-year evaluations. The hot-applied, non-JFR sealants appeared to have the most defects, and the defect most commonly noted was bubbling. The bubbling that had occurred did not appear to be affecting the sealant's performance, but the potential for failure exists. The amount of bubbling had increased at the 1-year evaluations, and a rating system was developed to allow quantitative comparison between the materials. The average overall bubble rating from the field evaluations indicates that the hot-applied, non-JFR sealants exhibit

more bubbling than the hot-applied, JFR sealants. The use of a primer did not appear to have a significant affect on the bubbling.

The average bubble ratings from the field were less than those obtained during the additional bubble study conducted by Crafco. This difference could have been caused by the amount of moisture in the new concrete used in the test section as compared to the moisture content of the old concrete used for the field evaluations.

The adhesion failures had increased between the 6-month and 1-year evaluations. None of the adhesion failures were greater than one percent of the total linear footage and most of them appeared to initiate in areas where some of the old joint sealant had been left on the joint face. Several of the hot-applied sealants had begun to peel away from the joint face at the pavement surface, but the depth of the failure was only 1/16 to 1/8 in. These areas were not classified as adhesion failures because they were not full depth.

Only one small area in Area 2, Section 5 had received any fuel spillage. The total surface area of the spill was approximately 1 sq ft. The sealant used in this section was Koch Product 9012, and it did not experience any failures related to the fuel spillage.

The cold-applied, single- and two-component sealants appear to be performing better than the hot-applied sealants. There are differences between the moduli of the cold-applied sealants as indicated by the coin test but since all of the materials appear to be performing satisfactorily, no conclusions were made concerning which material would be best.

The hot-applied, JFR sealants appeared to be performing better than the hot-applied, non-JFR sealants. This observation was based on the amount of bubbling experienced in the non-JFR sealants. Even though there is a perception of better performance of one type of sealant versus another, none of the in-place sealants could be classified as failed.

Several conclusions and recommendations can be made from this study:

a. All of the sealants installed at Fairchild AFB performed satisfactorily for at least 1 year. It is recommended that additional evaluations be conducted to determine the actual life cycle of these sealants. The evaluations would enable the enhanced performance claims of the "improved" non-JFR and JFR sealants developed during this project to be determined.

b. The adhesion failures that are evident appear to have been caused by residual material on the joint face. Therefore, the requirements for joint preparation and cleanliness as described in the U.S. Army Corps of Engineers Guide Specification (CEGS) 02592 "Field Molded Sealants for Sealing Joints in Rigid Pavements" appear to be justified. It is recommended that current guide specifications continue to require "hospital" clean joints. Most manufacturers require extensive cleaning of

the joint before they will warranty their material and the field data indicate that sealant performance related to adhesion is improved with this amount of cleaning. The inclusion and enforcement of the strict joint preparation procedures by other user agencies should significantly increase the effective life of the sealant. Additionally, including the "improved" sealants for projects located in colder climates could provide an even greater effective sealant life. The draft specifications have been discussed in ASTM task groups. This is the first step to have them included in ASTM standards.

c. The bubbling problem exhibited by hot-applied sealants specifically non-JFR sealants has not been eliminated. The development of the primer system exhibits significant promise, but there are still problem areas that need to be resolved. It is recommended that work continues in this area to determine if the bubbling tendencies can be eliminated. The draft specification has been included in this report to provide other researchers with a potential starting point to address the bubbling problem.

d. The cold-applied, single-component sealants appear to be performing satisfactorily in the field. However, there is a problem if a user agency wants to specify one of these sealants. The problem is that there is not an industry accepted material specification that can be used in project specifications to allow their use. The American Society of Testing and Materials (ASTM) is currently working on such a specification, but work on the specification has been slow. It is recommended that some type of test or series of tests be developed that would evaluate the applicability of specific sealants to specific applications.

References

American Association of State Highway and Transportation Officials. 1990. "Concrete Joint-Sealer, Hot-Poured, Elastic Type, "AASHTO M 173-84 Washington, DC.

American Society for Testing and Materials. 1978. "Joint Sealants, Hot Poured for Concrete and Asphalt Pavements," ASTM D 3405-78, Philadelphia, PA.

_____. 1980. "Concrete Joint Sealer, Hot-Poured Elastic Type," ASTM D 1190-74 (Reapproved 1980), Philadelphia, PA.

_____. 1990. "Joint Sealant, Hot Poured, Jet-Fuel-Resistant Type for Portland Cement Concrete and Tar-Concrete Pavements," ASTM D 3581-90, Philadelphia, PA.

_____. 1991. "Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant Type for Portland Cement Concrete Pavements," ASTM D 3569-91, Philadelphia, PA.

Burr, I. W. 1974. "Applied Statistical Methods," Academic Press, Inc., New York.

Federal Specification SS-S-1401C. 1984a (Aug). "Sealant, Joint, Non-Jet-Fuel-Resistant, Hot-Applied for Portland Cement and Asphalt Concrete Pavements," Washington, DC.

Federal Specification SS-S-1614A. 1984b (Aug). "Sealants, Joint, Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Tar Concrete Pavements," Washington, DC.

Federal Specification SS-S-200E. 1988 (Aug). "Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied for Portland Cement Concrete Pavement," Washington, DC.

Iowa Department of Transportation. 1984. "Standard Specifications for Highway and Bridge Construction," Section 4136.02, Ames, IA.

Kansas Department of Transportation. 1986 (Jul). "Specification for Hot-Applied Crack Sealant," Specification TS 109.6, Topeka, KS.

Lynch, Larry N., White, Dewey W., and Chehovits, James. (1993). "Improved Materials and Processes for Sealing and Resealing Joints in Portland Cement Concrete Pavements-Laboratory Evaluation," Construction Productivity Advancement Research Program, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Michigan Department of Transportation. 1987 (Mar). "Special Provision for Low-Modulus Hot-Poured Joint Sealant," Bureau of Highways, Lansing, MI.

Minnesota Department of Transportation. 1988. "Standard Specifications for Construction," Section 3723, Concrete Joint and Crack Sealer (Hot-Poured Elastic Type), St. Paul, MN.

Missouri Highway and Transportation Commission. 1988. "Missouri Standard Specification for Highway Construction," Section 1057.1.3, Concrete Joint Sealer, Hot-Poured Elastic Type, Jefferson City, MO.

South Dakota Department of Transportation. (undated). "Minimum Specification for Rubber Asphalt and Hot-Poured Elastic Joint Sealer," Pierre, SD.

_____ . 1985. "Standard Specifications for Roads and Bridges," Section 870. Concrete Joint Sealer, Pierre, SD.

U.S. Army Corps of Engineers Guide Specification for Military Construction. 1991 (April). "Field Molded Sealants for Joint Sealing in Rigid Pavements," U.S. Army Corps of Engineers, Huntsville Division, Bulletin Board (205) 955-5436, P.O. Box 1600, Huntsville, AL 35807.

U.S. Army Corps of Engineers Handbook of Concrete and Cement. 1992. "Standard Specification for Joint Sealants, Cold-Applied, Non-Jet-Fuel-Resistant for Rigid and Flexible Pavements," CRD-C 527-88, Washington, DC.

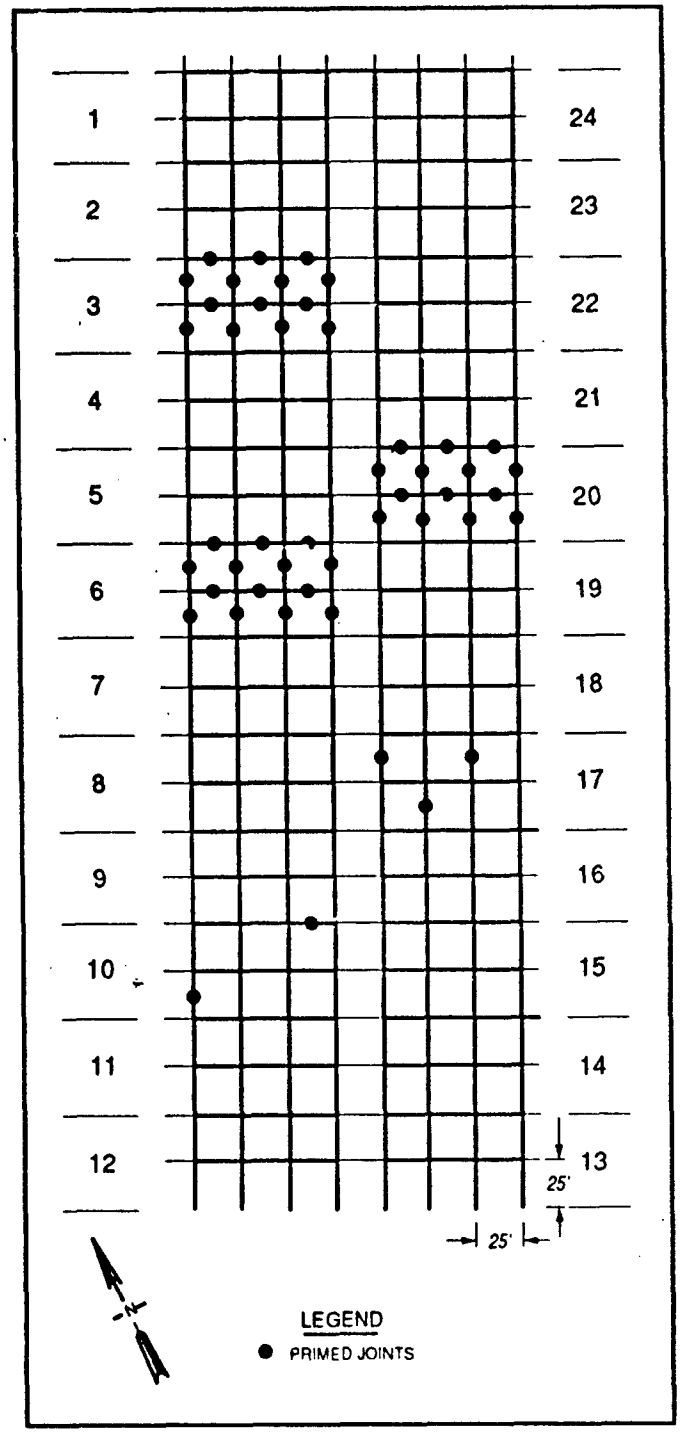


Figure 1. Area 1 sealant layout

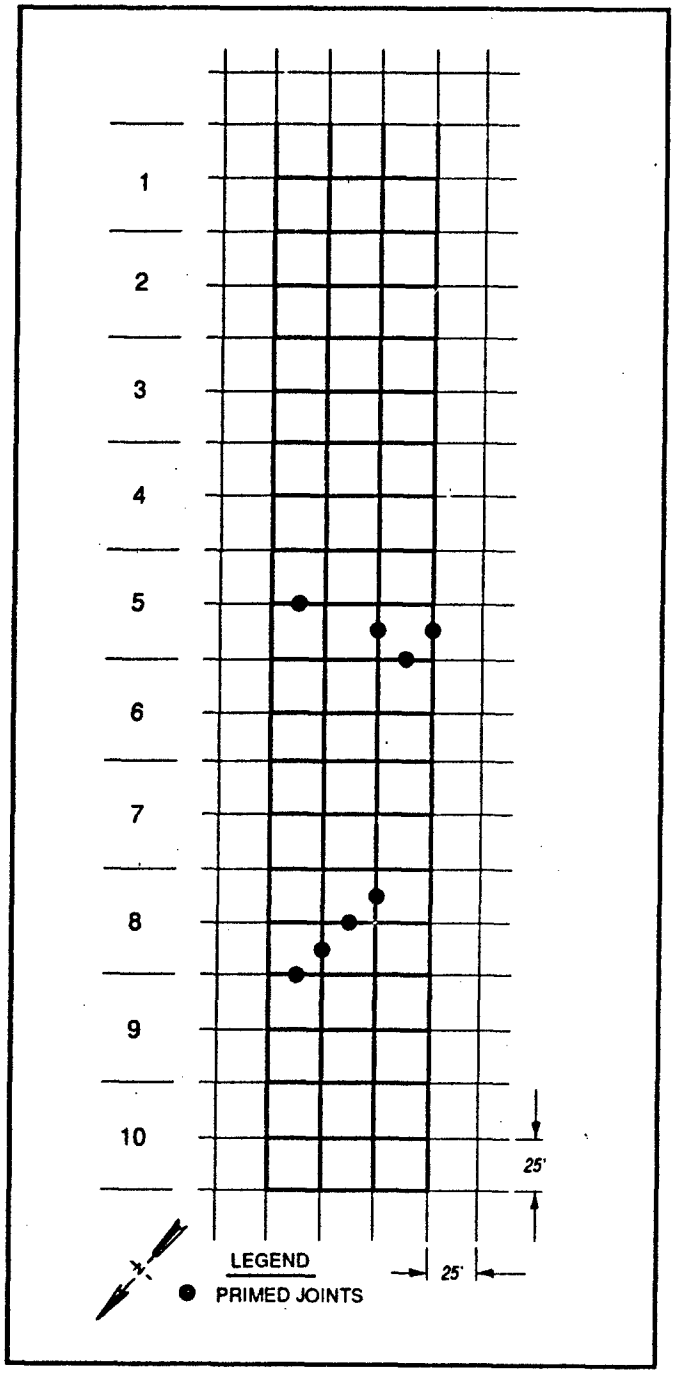


Figure 2. Area 2 sealant layout

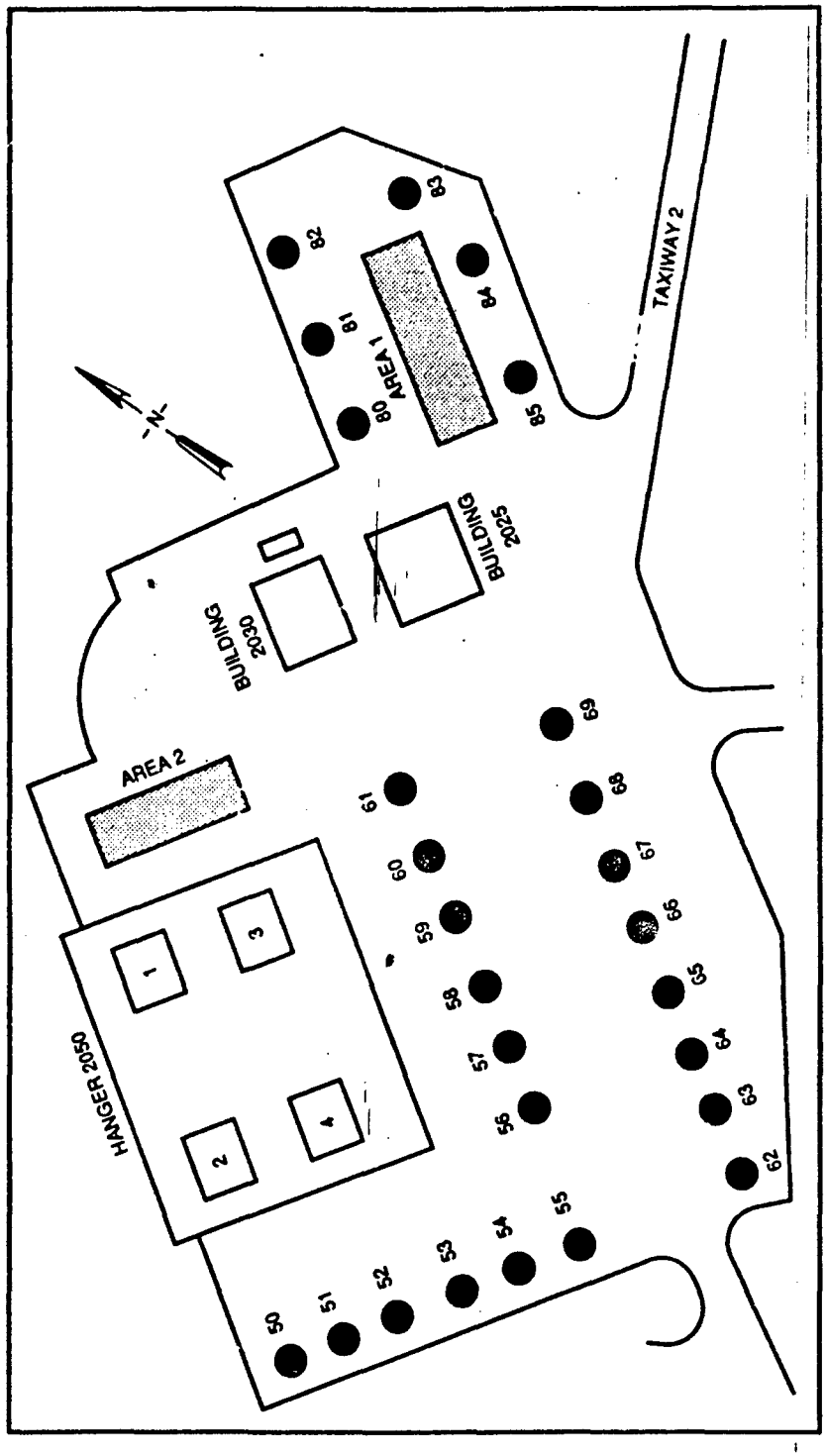


Figure 3. Location of test areas at Fairchild AFB

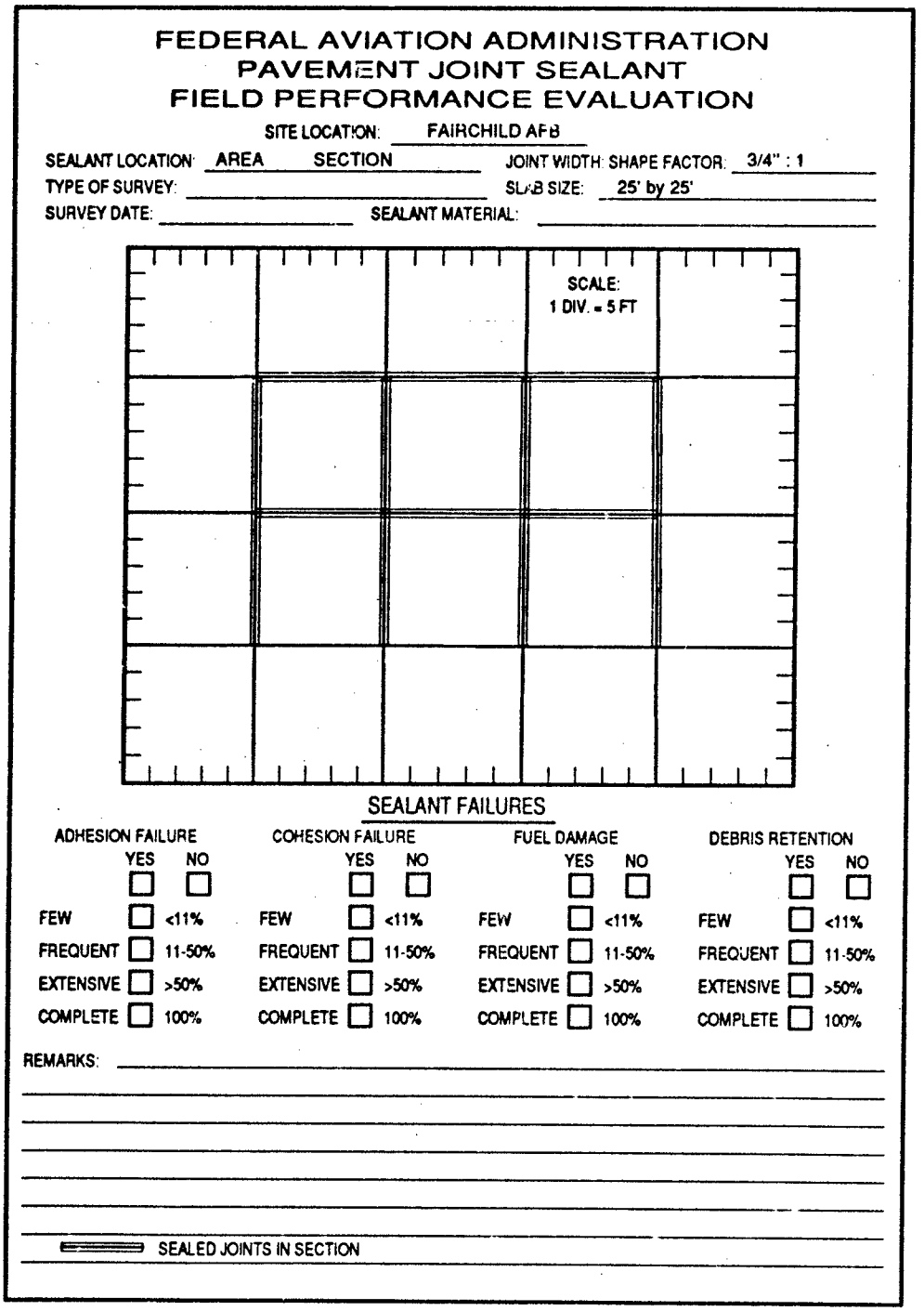


Figure 4. Field evaluation sheet

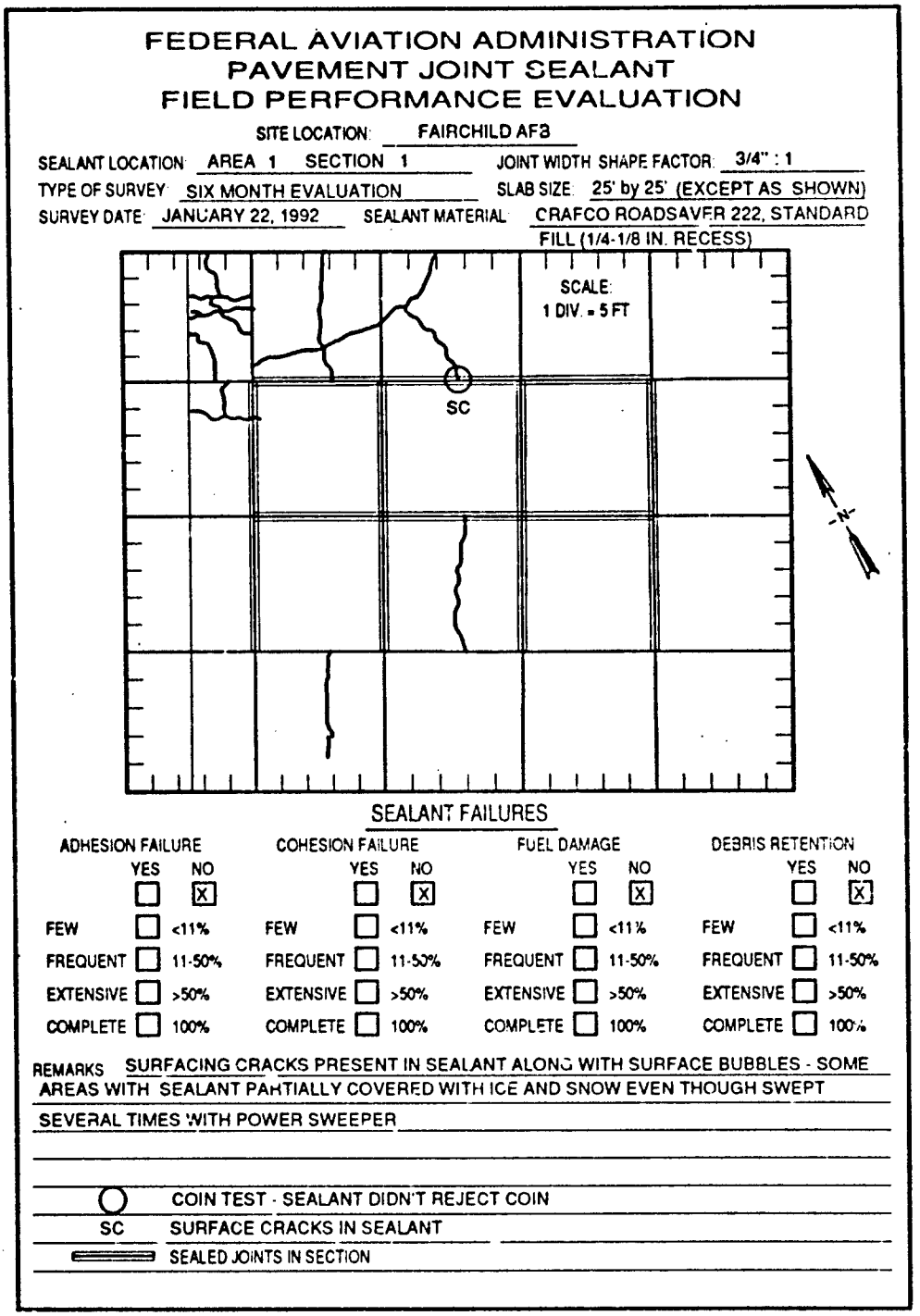


Figure 5. Six-month field evaluation - area 1 section 1

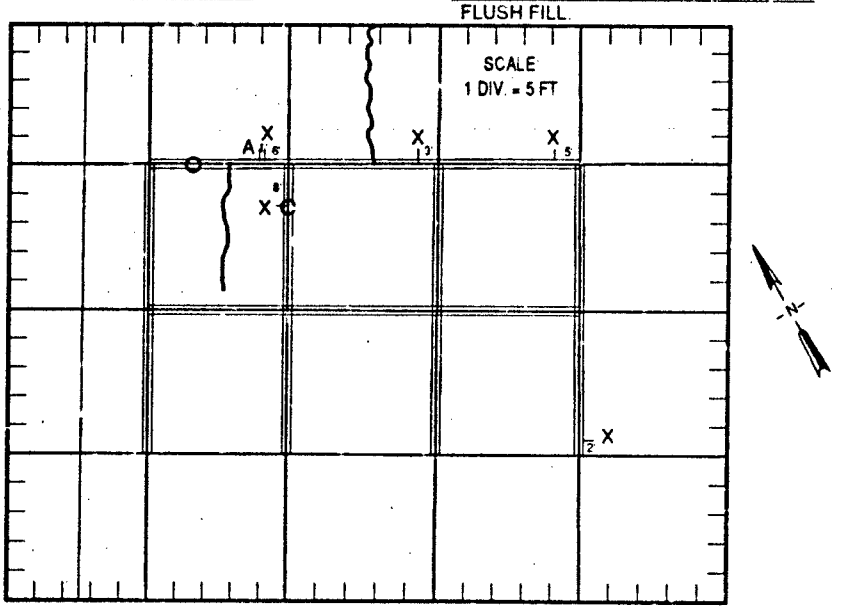
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 2 JOINT WIDTH: SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: CRAFCO ROADSAVER 222, FLUSH FILL



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐	<11%	☐	<11%	☐	<11%	☐	<11%
FREQUENT	☐	11-50%	☐	11-50%	☐	11-50%	☐	11-50%
EXTENSIVE	☐	>50%	☐	>50%	☐	>50%	☐	>50%
COMPLETE	☐	100%	☐	100%	☐	100%	☐	100%

REMARKS: SOME AREAS WITH SEALANT PARTIALLY COVERED WITH ICE AND SNOW EVEN THOUGH SWEPT SEVERAL TIMES WITH POWER SWEEPER, SURFACE BUBBLES PRESENT IN SEVERAL JOINTS.

SEALED JOINTS IN SECTION O - SEALANT RETAINED COIN

A - SNOW PLOW ABRASION X - SURFACE BUBBLES IN SEALANT

Figure 6. Six-month field evaluation - area 1 section 2

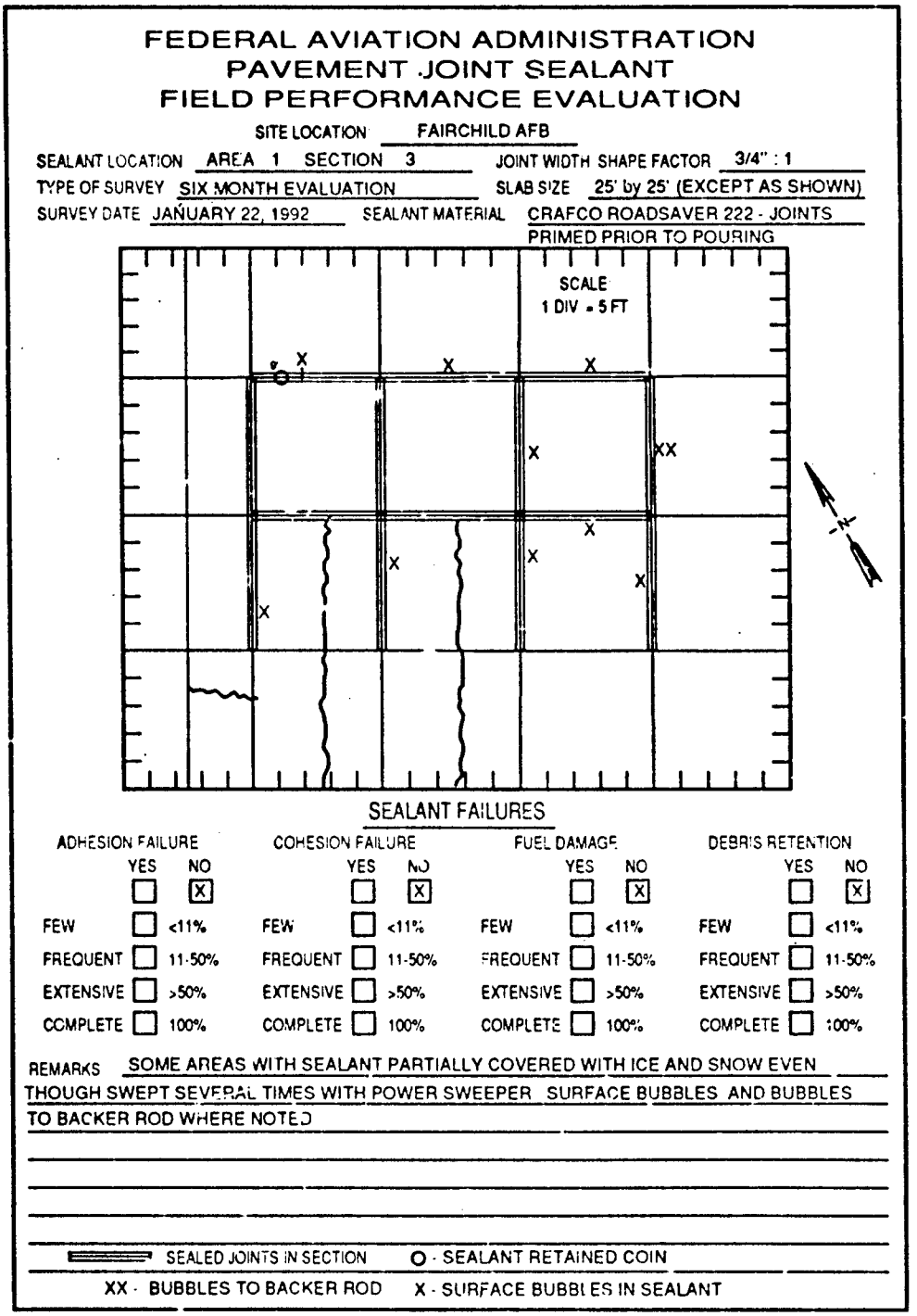


Figure 7. Six-month field evaluation - area 1 section 3

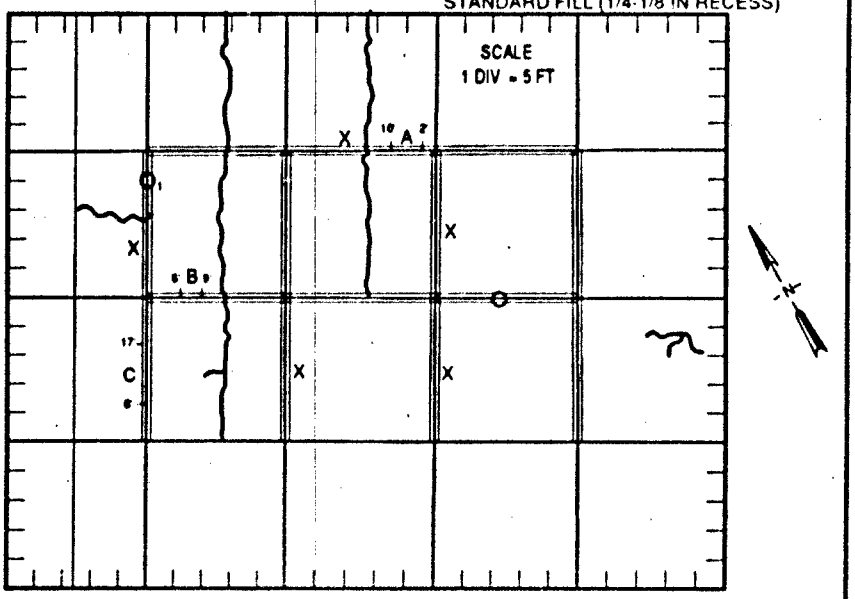
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 4 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY SIX MONTH EVALUATION SLAB SIZE 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE JANUARY 22, 1992 SEALANT MATERIAL CRAFCO IMPROVED NON-JFR STANDARD FILL (1/4-1/8 IN RECESS)



SEALANT FAILURES

	ADHESION FAILURE YES [X] NO [ ]	COHESION FAILURE YES [ ] NO [X]	FUEL DAMAGE YES [ ] NO [X]	DEBRIS RETENTION YES [ ] NO [X]
FEW	[X] <11%	[ ] <11%	[ ] <11%	[ ] <11%
FREQUENT	[ ] 11-50%	[ ] 11-50%	[ ] 11-50%	[ ] 11-50%
EXTENSIVE	[ ] >50%	[ ] >50%	[ ] >50%	[ ] >50%
COMPLETE	[ ] 100%	[ ] 100%	[ ] 100%	[ ] 100%

REMARKS SOME AREAS WITH SEALANT PARTIALLY COVERED WITH ICE AND SNOW EVEN THOUGH SWEPT SEVERAL TIMES WITH POWER SWEEPER, SURFACE BUBBLES AND SEPARATION OF SEALANT FROM CONCRETE WHERE NOTED

A - 1/8 IN. ADHESIVE FAILURE - (PULL AWAY ON SURFACE)

B - 1/8 IN. ADHESIVE FAILURE - (PULL AWAY ON SURFACE)

C - 1/8 IN. ADHESIVE FAILURE - (PULL AWAY ON SURFACE)

O_1 - SEALANT RETAINED COIN, HOWEVER WENT IN EASY

SEALED JOINTS IN SECTION

O - SEALANT RETAINED COIN

X - SURFACE BUBBLES IN SEALANT

Figure 8. Six-month field evaluation - area 1 section 4

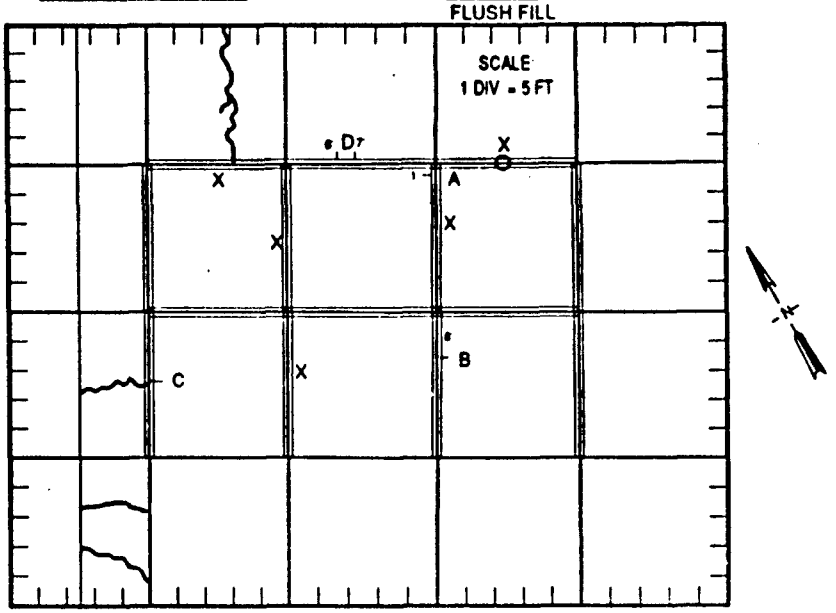
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 5 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY SIX MONTH EVALUATION SLAB SIZE 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE JANUARY 22, 1992 SEALANT MATERIAL CRAFCO IMPROVED NON-JFR, FLUSH FILL



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X <11%		FEW	<11%	FEW	<11%	FEW	<11%
FREQUENT	11-50%		FREQUENT	11-50%	FREQUENT	11-50%	FREQUENT	11-50%
EXTENSIVE	>50%		EXTENSIVE	>50%	EXTENSIVE	>50%	EXTENSIVE	>50%
COMPLETE	100%		COMPLETE	100%	COMPLETE	100%	COMPLETE	100%

REMARKS: SOME AREAS WITH SEALANT PARTIALLY COVERED WITH ICE AND SNOW EVEN THOUGH SWEPT SEVERAL TIMES WITH POWER SWEEPER, SURFACE BUBBLES AND ADHESION SEPARATION NOTED.

O - SEALANT RETAINED COIN
A - SEALANT NOT ADHERED TO CONCRETE
B - 3-IN. ADHESION FAILURE
C - 3-IN. ADHESION FAILURE
SEALED JOINTS IN SECTION
D - SNOW PLOW DAMAGE
X - SURFACE BUBBLES IN SEALANT

Figure 9. Six-month field evaluation - area 1 section 5

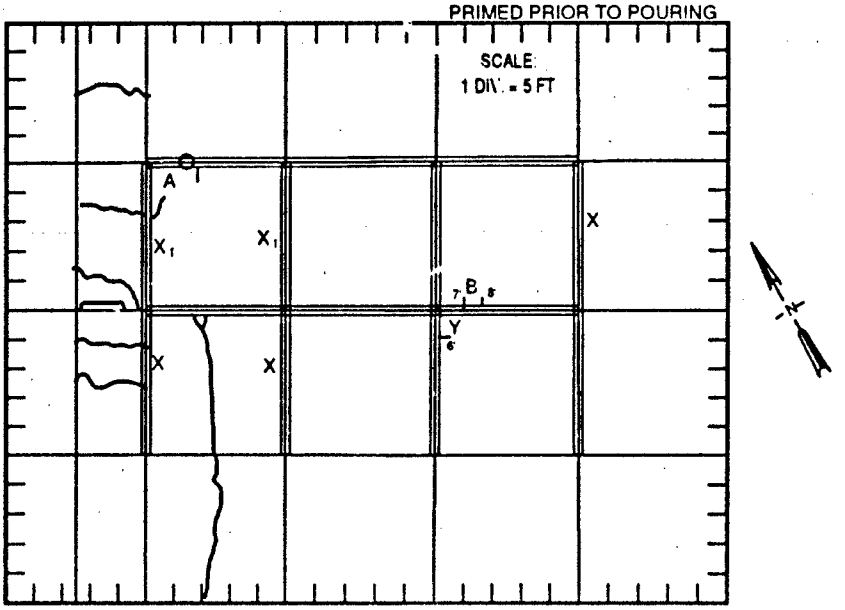
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 6 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: CRAFCO IMPROVED NON-JFR, JOINTS PRIMED PRIOR TO POURING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[ ]	[X]	[ ]	[X]
FEW	[X] <11%		[ ] <11%		[ ] <11%		[ ] <11%	
FREQUENT	[ ] 11-50%		[ ] 11-50%		[ ] 11-50%		[ ] 11-50%	
EXTENSIVE	[ ] >50%		[ ] >50%		[ ] >50%		[ ] >50%	
COMPLETE	[ ] 100%		[ ] 100%		[ ] 100%		[ ] 100%	

REMARKS: SOME AREAS WITH SEALANT PARTIALLY COVERED WITH ICE AND SNOW EVEN THOUGH SWEPT SEVERAL TIMES WITH POWER SWEEPER. SURFACE BUBBLES AND ADHESION SEPARATION NOTED IN SEALANT.

SEALED JOINTS IN SECTION

0 - SEALANT RETAINED COIN
A - ADHESION FAILURE
B - 1/8 IN. SURFACE PULLED AWAY IN SEALANT
X - SOME BUBBLING IN SEALANT
X_1 - MAJOR BUBBLING IN SEALANT
Y - BUBBLES IN SEALANT TO 1/2-IN. DIAMETER

Figure 10. Six-month field evaluation - area 1 section 6

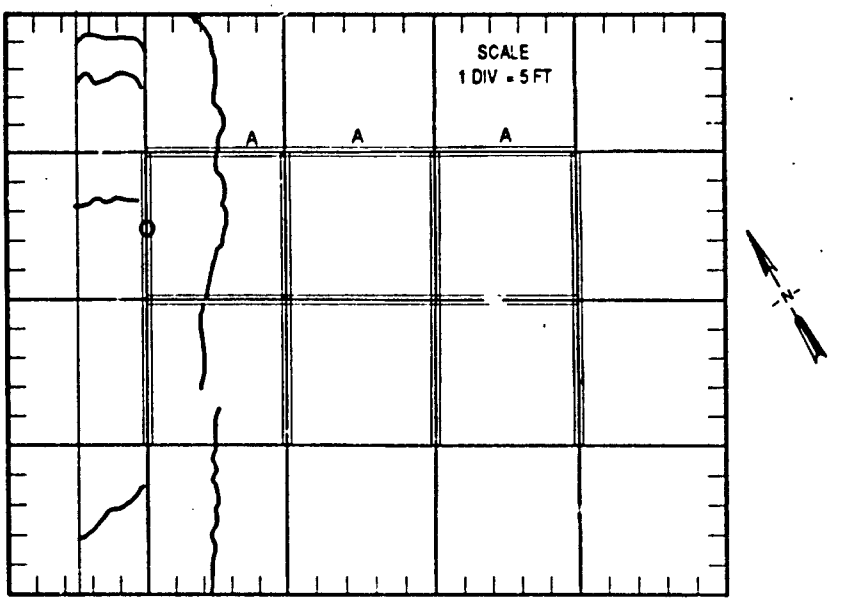
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 7 JOINT WIDTH SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: CRAFCO ROADSAVER SILICONE



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS: SOME AREAS WITH SEALANT PARTIALLY COVERED WITH ICE AND SNOW EVEN THOUGH SWEPT SEVERAL TIMES WITH POWER SWEEPER

O- SEALANT REJECTED COIN

SEALED JOINTS IN SECTION

A - PAINT OVER JOINT SEALANT

Figure 11. Six-month field evaluation - area 1 section 7

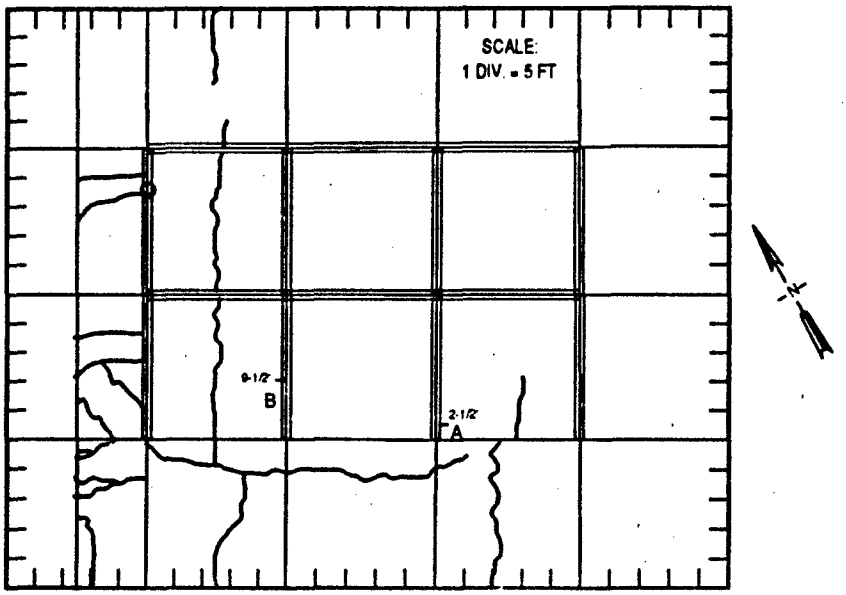
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 8 JOINT WIDTH, SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: MOBAY BAYSILONE 960



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X <11%		FEW ☐ <11%		FEW ☐ <11%		FEW ☐ <11%	
FREQUENT	☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%	
EXTENSIVE	☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%	
COMPLETE	☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%	

REMARKS: SEALANT DISCOLORED OVER ALL JOINTS IN SECTION.

O - SEALANT REJECTED COIN

A - 1-IN. ADHESION FAILURE - OLD JOINT SEALANT IN JOINT

B - 3-IN. ADHESION FAILURE - OLD JOINT SEALANT IN JOINT

SEALED JOINTS IN SECTION

Figure 12. Six-month field evaluation - area 1 section 8

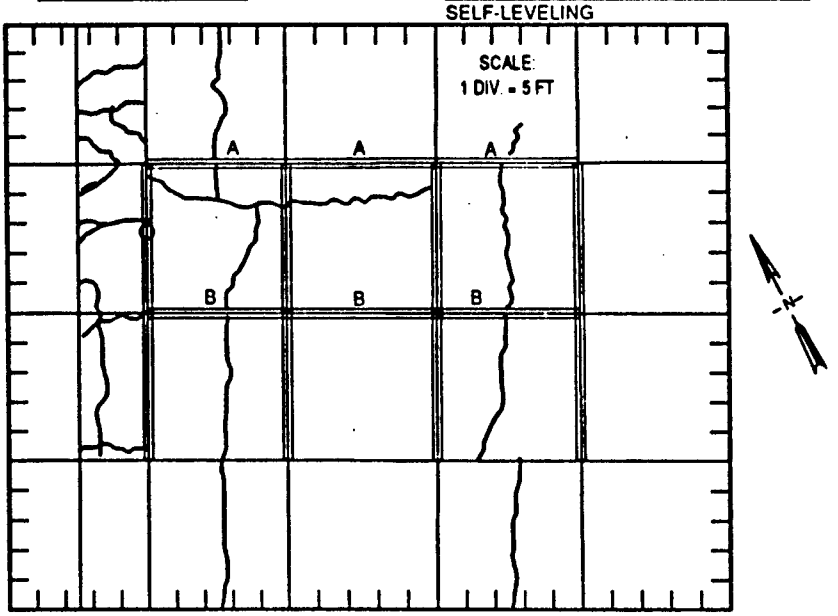
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 9 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY SIX MONTH EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE JANUARY 22, 1992 SEALANT MATERIAL MOBAY BAYSILONE 960 SELF-LEVELING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS SEALANT DISLOLORED IN AREAS NOTED

O - SEALANT REJECTED COIN

A - SEALANT PAINTED

SEALED JOINTS IN SECTION

B - SEALANT DISCOLORATION

Figure 13. Six-month field evaluation - area 1 section 9

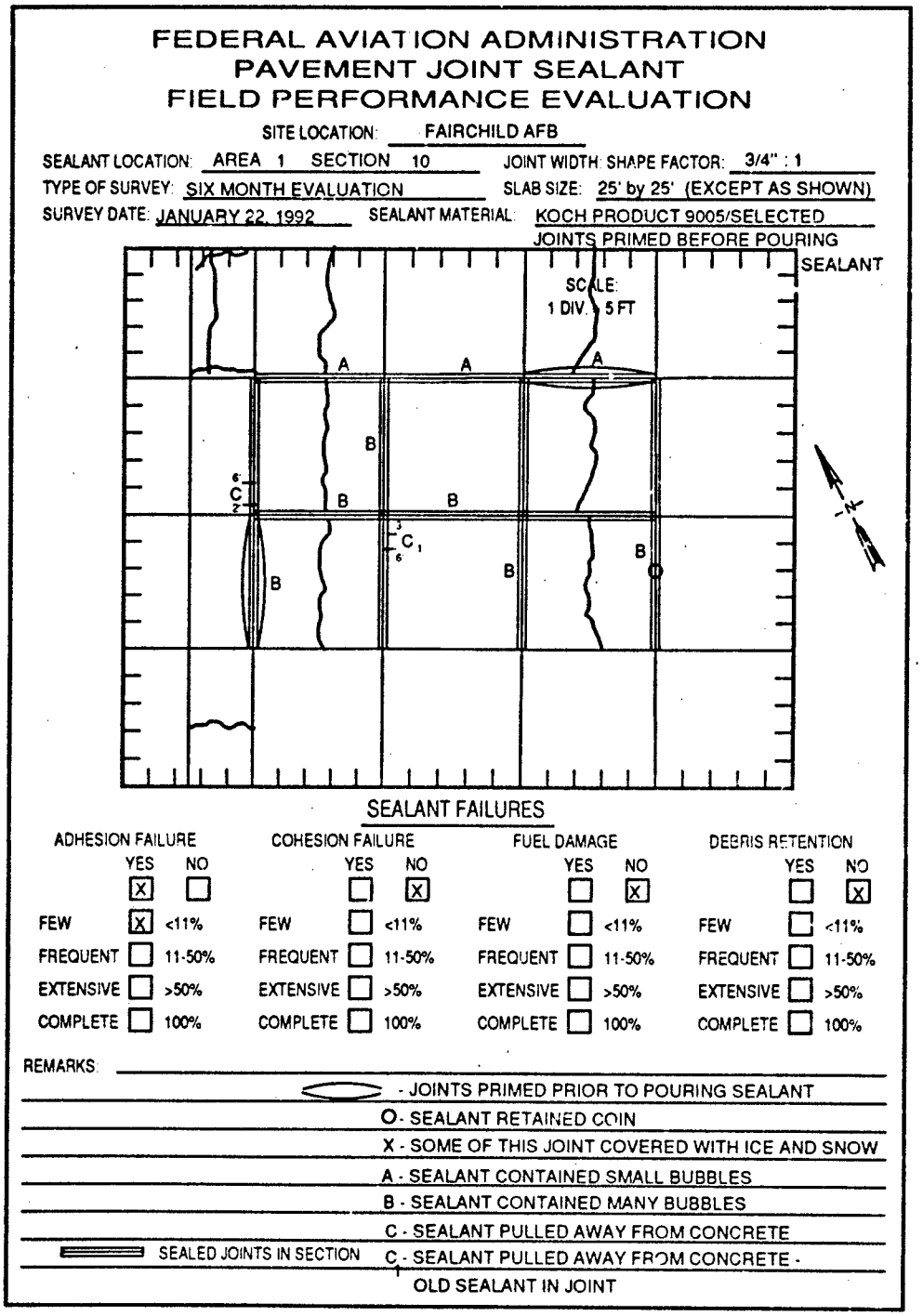


Figure 14. Six-month field evaluation - area 1 section 10

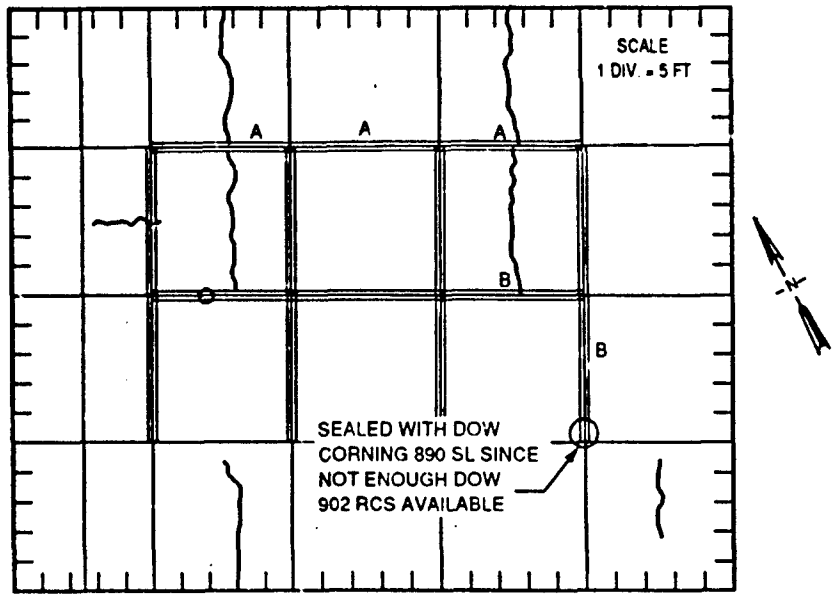
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 11 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY SIX MONTH EVALUATION SLAB SIZE 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE JANUARY 22, 1992 SEALANT MATERIAL DOW CORNING 902 RCS



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐	<11%	☐	<11%	☐	<11%	☐	<11%
FREQUENT	☐	11-50%	☐	11-50%	☐	11-50%	☐	11-50%
EXTENSIVE	☐	>50%	☐	>50%	☐	>50%	☐	>50%
COMPLETE	☐	100%	☐	100%	☐	100%	☐	100%

REMARKS

○ - SEALANT REJECTED COIN

A - SEALANT PAINTED

SEALED JOINTS IN SECTION

B - SEALANT COVERED WITH ICE AND SNOW

Figure 15. Six-month field evaluation - area 1 section 11

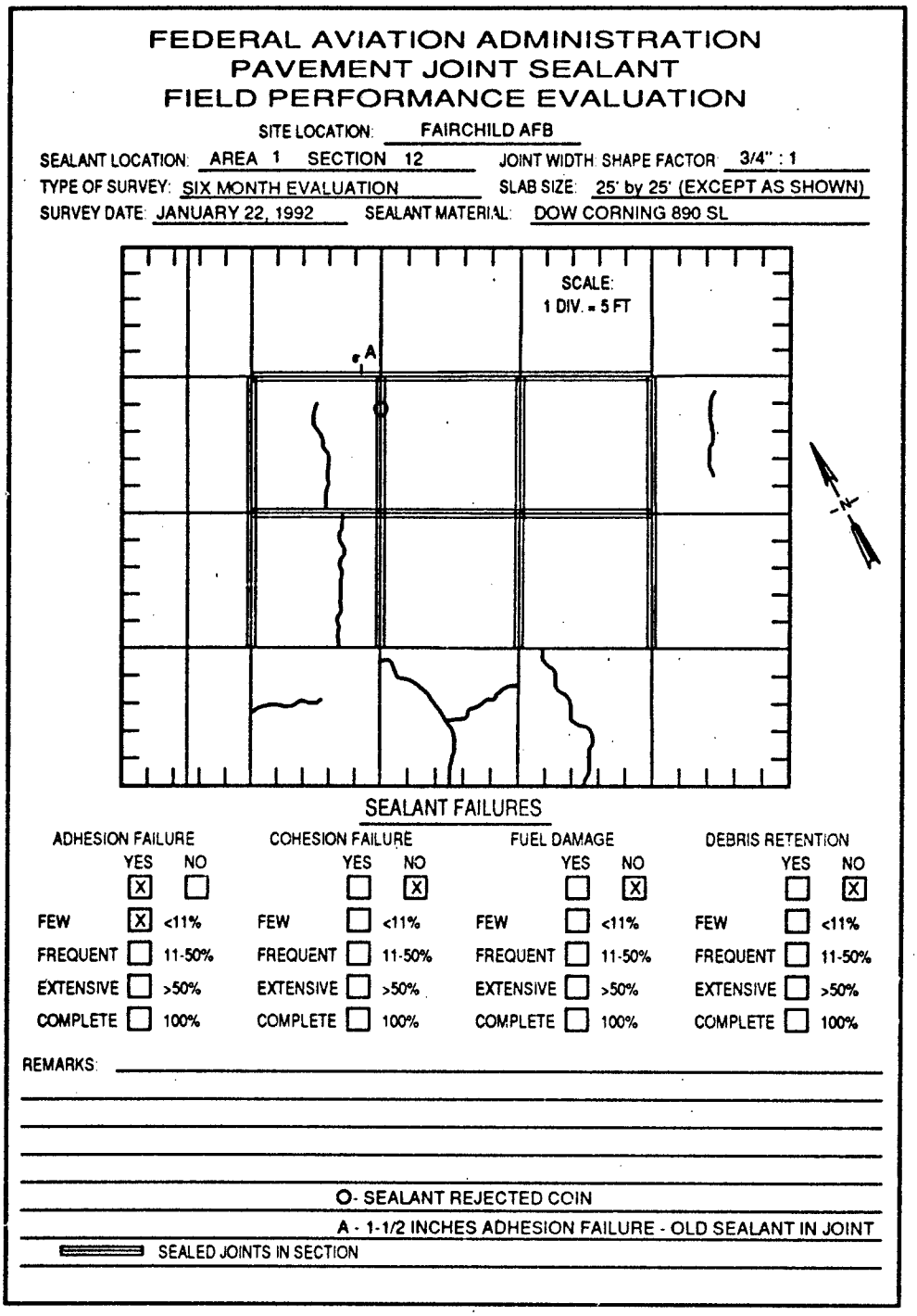


Figure 16. Six-month field evaluation - area 1 section 12

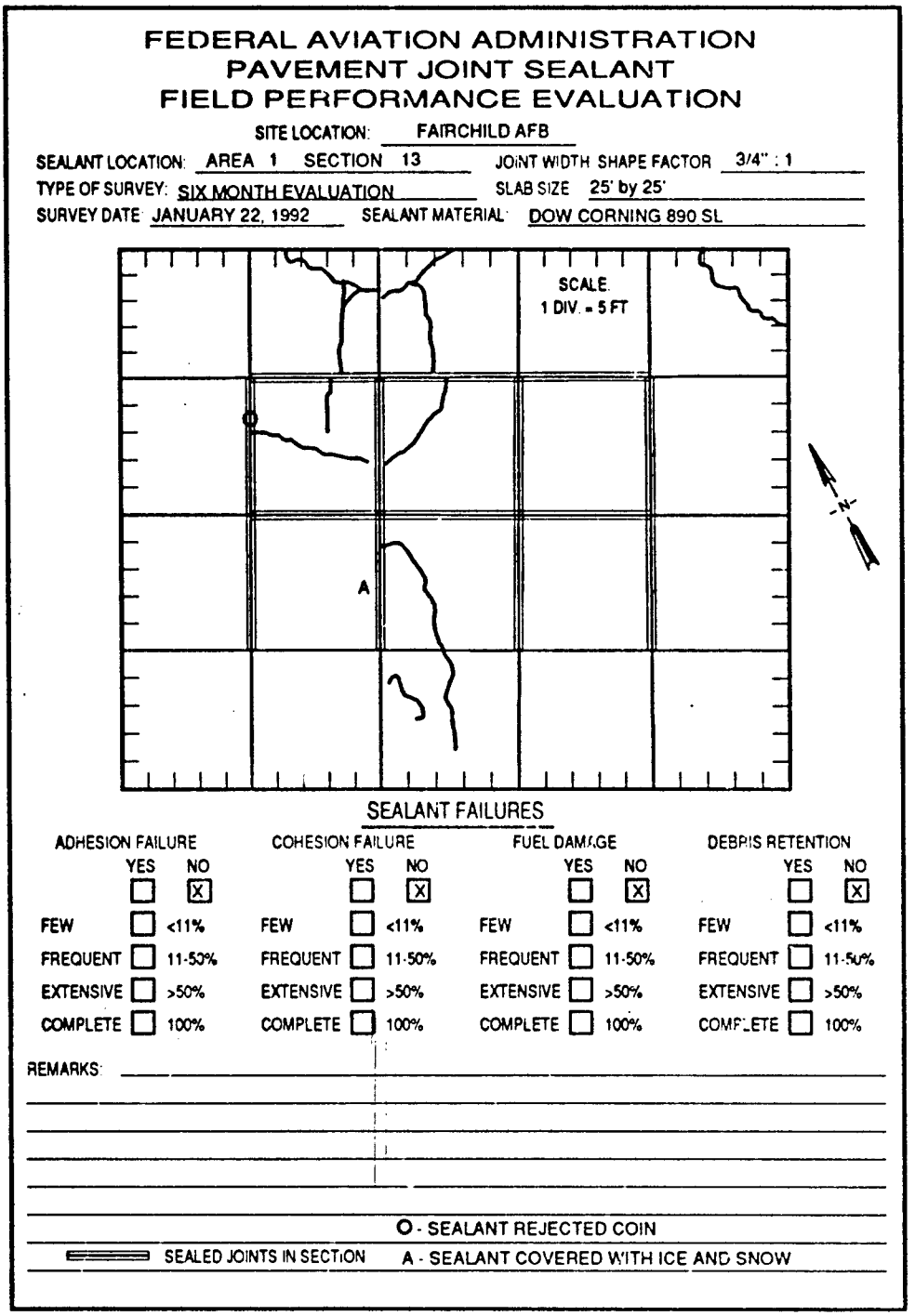


Figure 17. Six-month field evaluation - area 1 section 13

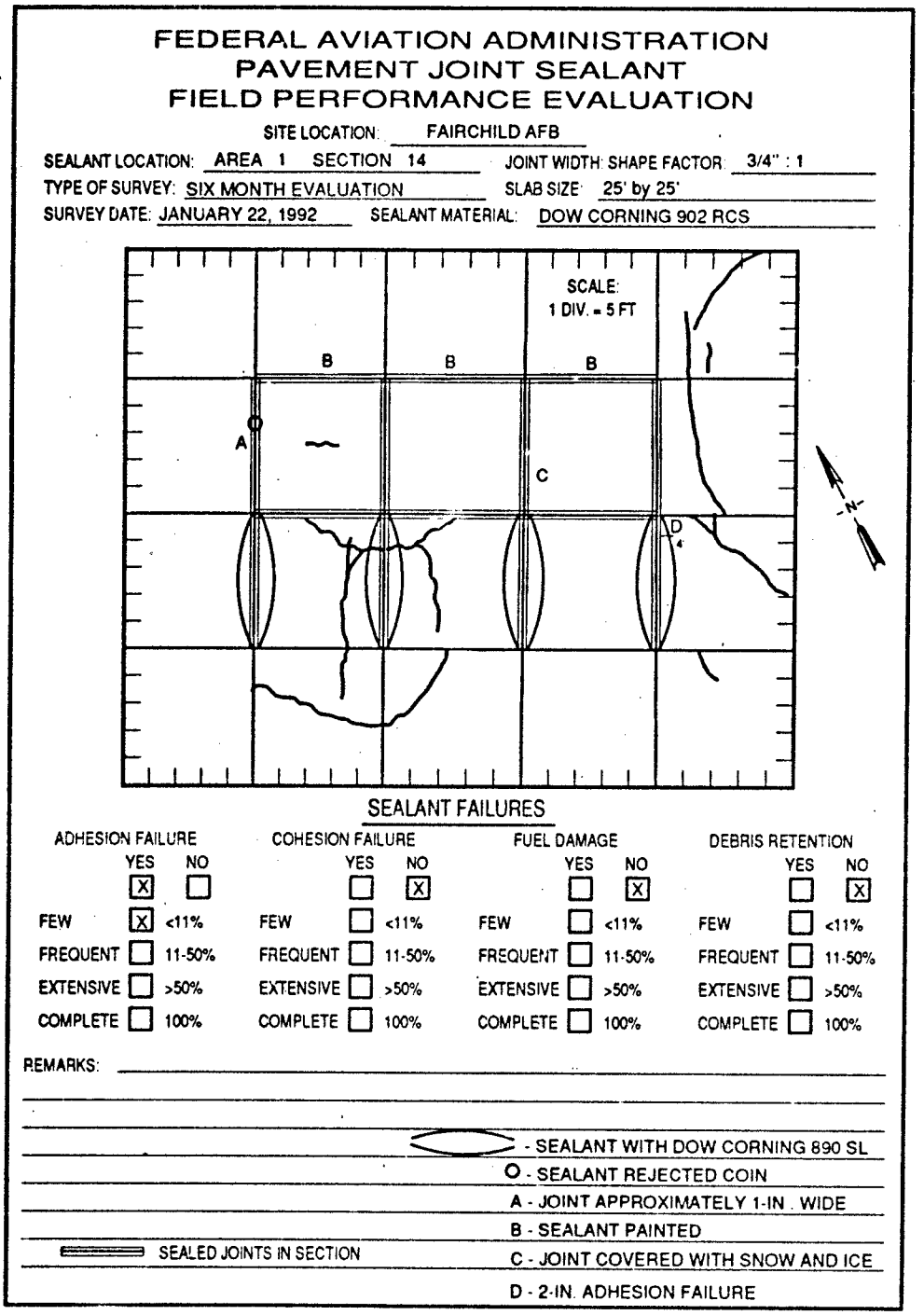


Figure 18. Six-month field evaluation - area 1 section 14

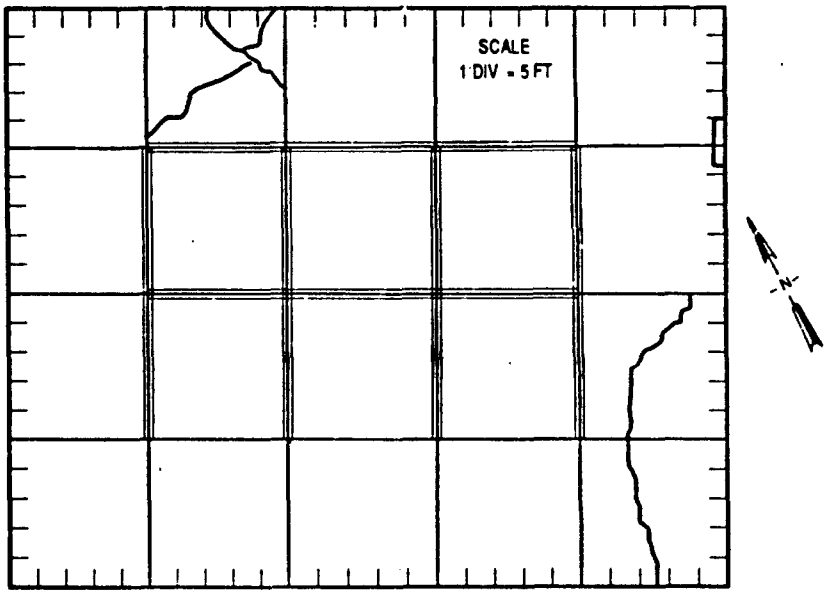
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 15 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: MOBAY BAYSILONE 960 SL



SEALANT FAILURES

	ADHESION FAILURE	COHESION FAILURE	FUEL DAMAGE	DEBRIS RETENTION
	YES ☐ NO ☒	YES ☐ NO ☒	YES ☐ NO ☒	YES ☐ NO ☒
FEW	☐ <11%	☐ <11%	☐ <11%	☐ <11%
FREQUENT	☐ 11-50%	☐ 11-50%	☐ 11-50%	☐ 11-50%
EXTENSIVE	☐ >50%	☐ >50%	☐ >50%	☐ >50%
COMPLETE	☐ 100%	☐ 100%	☐ 100%	☐ 100%

REMARKS: SEALANT IN ALL JOINTS DISCOLORED.

SEALED JOINTS IN SECTION

Figure 19. Six-month field evaluation - area 1 section 15

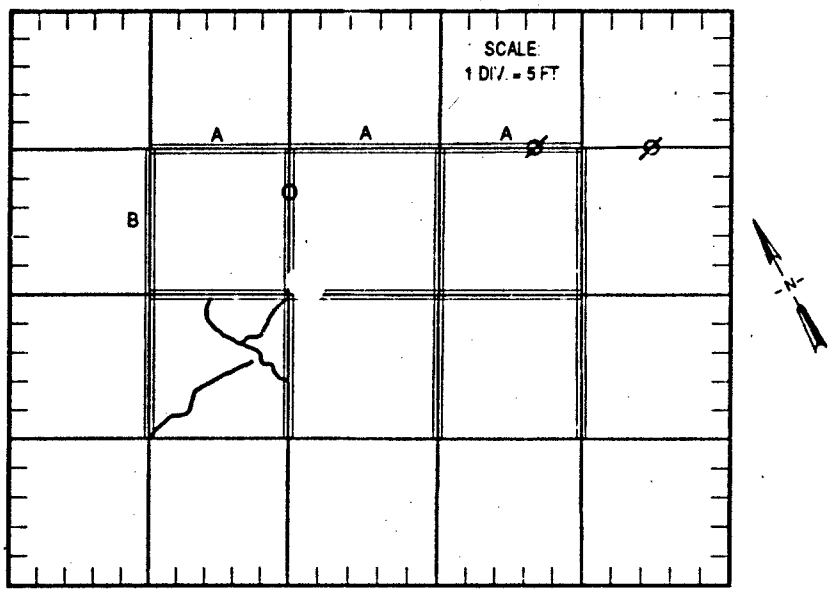
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 16 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: MOBAY BAYSILONE 960



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		FEW ☐ <11%		FEW ☐ <11%		FEW ☐ <11%	
FREQUENT	☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%	
EXTENSIVE	☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%	
COMPLETE	☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%	

REMARKS: SEALANT DISCOLORATION IN JOINTS.

Ø - TIE DOWN

O - SEALANT REJECTED COIN

SEALED JOINTS IN SECTION

A - SEALANT PAINTED

B - SEALANT COVERED WITH ICE AND SNOW

Figure 20. Six-month field evaluation - area 1 section 16

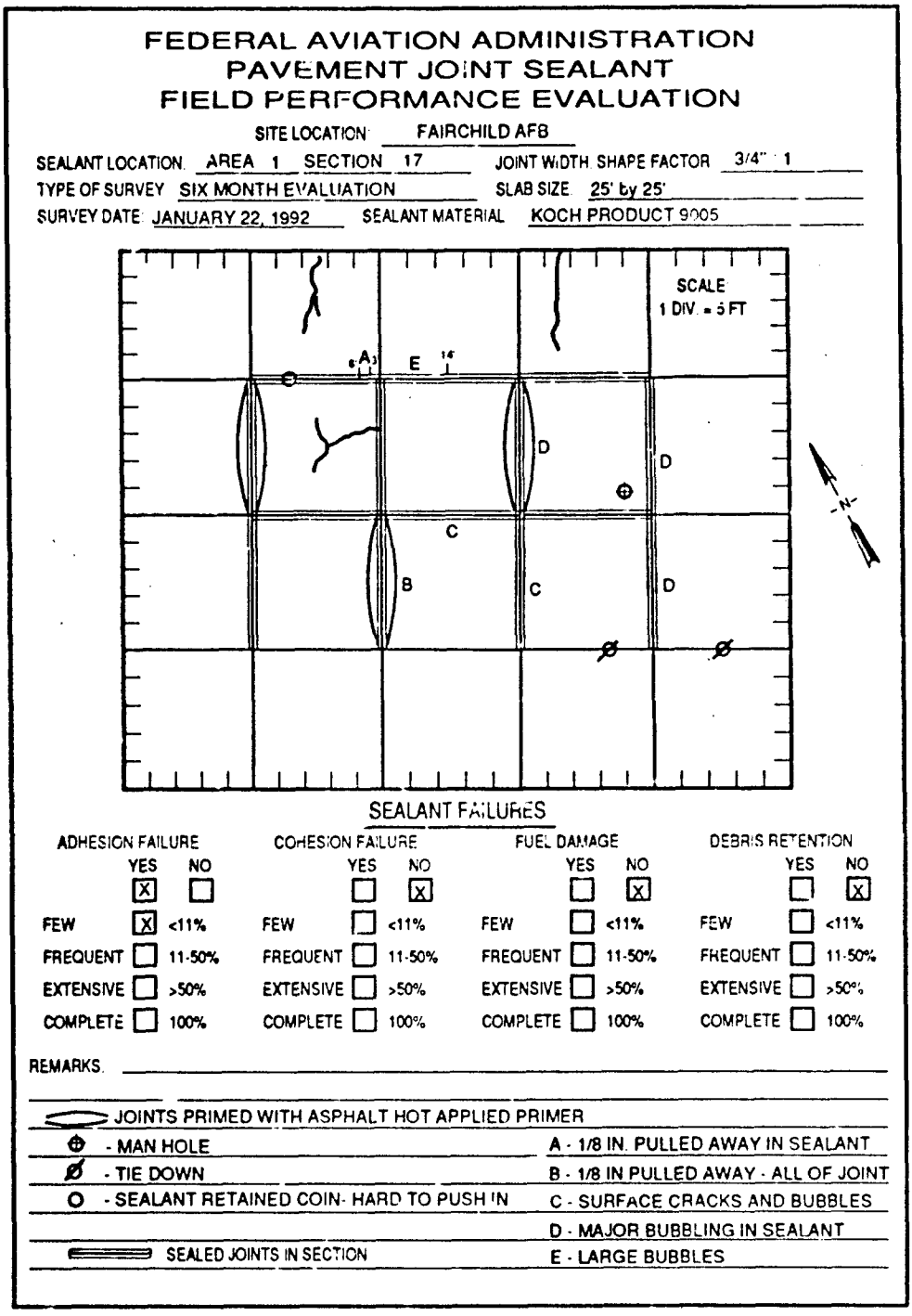


Figure 21. Six-month field evaluation - area 1 section 17

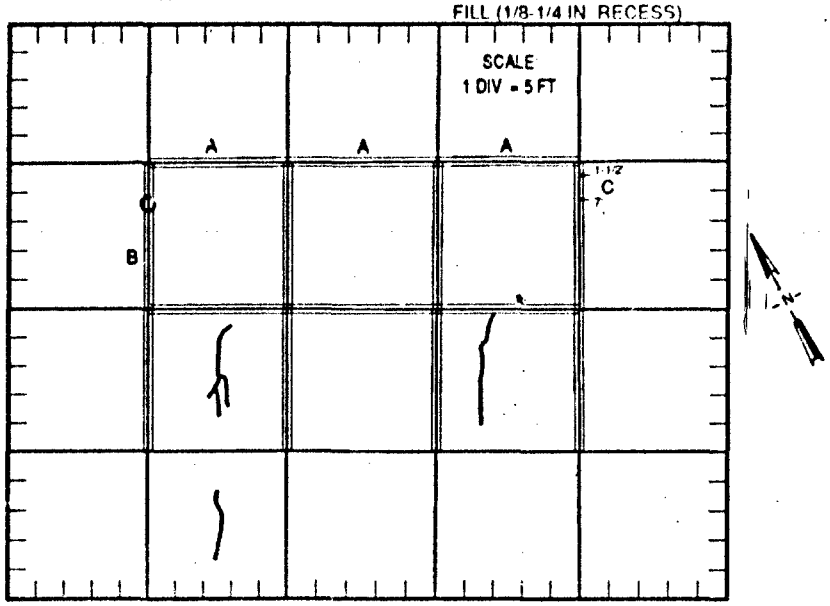
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 18 JOINT WIDTH SHAPE FACTOR 3/4" 1

TYPE OF SURVEY SIX MONTH EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JANUARY 22, 1992 SEALANT MATERIAL CRAFCO ROADSAVER 222, STANDARD FILL (1/8-1/4 IN RECESS)



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS GENERAL SURFACE CRACKS AND BUBBLING IN AREAS NOTED

O - SEALANT REJECTED COIN (SLOWLY)
A - SEALANT PAINTED
B - SURFACE BUBBLING
SEALED JOINTS IN SECTION
C - SEALANT BUBBLING

Figure 22. Six-month field evaluation - area 1 section 18

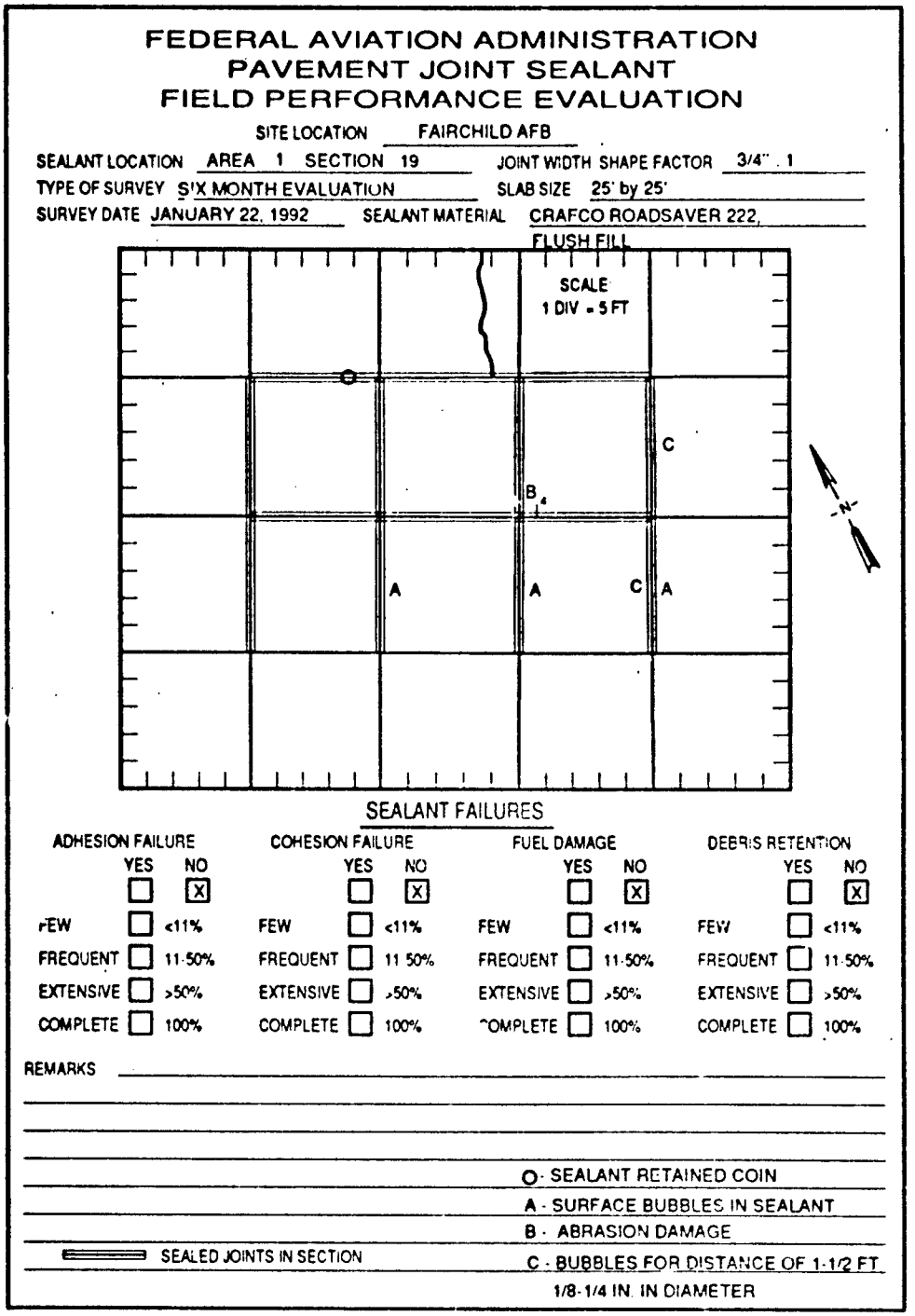


Figure 23. Six-month field evaluation - area 1 section 19

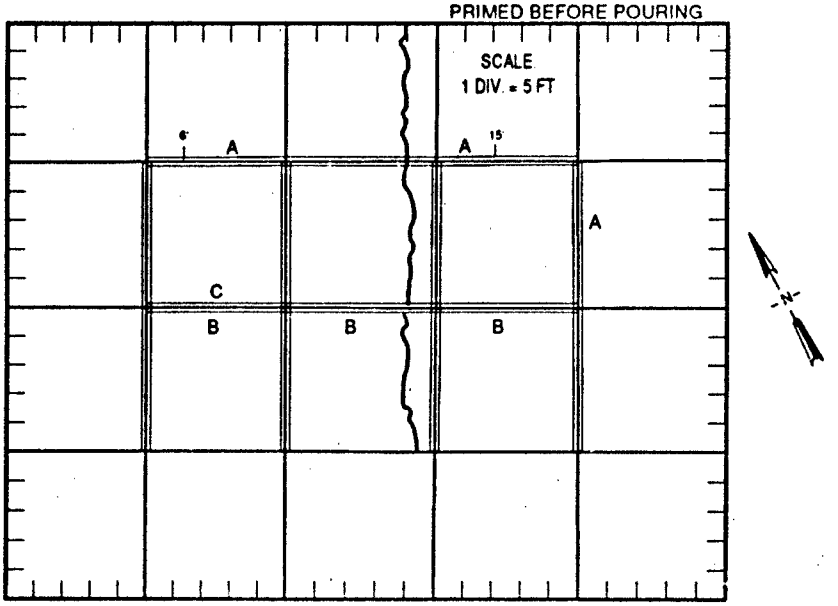
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 20 JOINT WIDTH: SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: CRAFCO ROADSAVER 222, JOINTS PRIMED BEFORE POURING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS:

A - MANY BUBBLES IN SEALANT

B - MANY BUBBLES IN SEALANT, 1/8-1/4 IN. DIAMETER

SEALED JOINTS IN SECTION

C - SOME BUBBLES 1/2-IN. IN DIAMETER

Figure 24. Six-month field evaluation - area 1 section 20

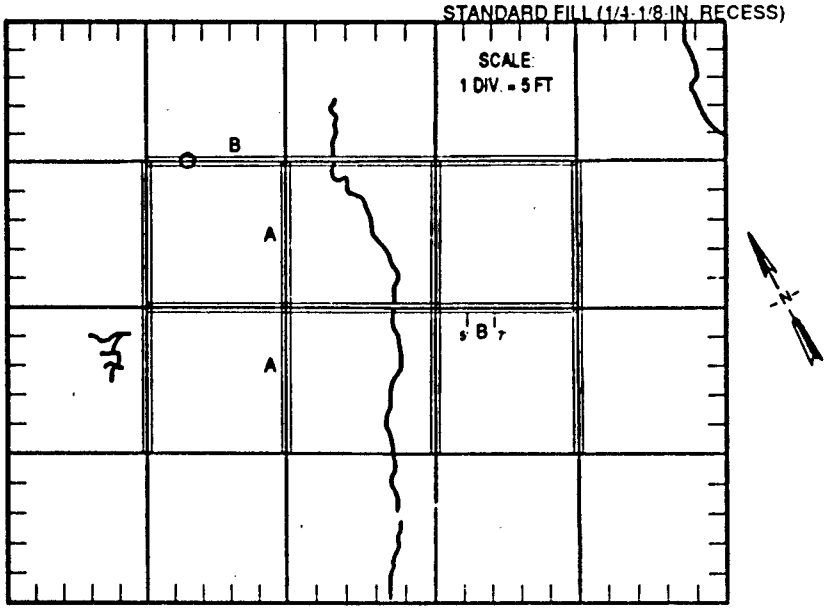
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 21 JOINT WIDTH: SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: CRAFCO IMPROVED NON-JFB, STANDARD FILL (1/4-1/8 IN. RECESS)



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS: ICE/SNOW SLUSH ON ALL JOINTS.

O - SEALANT RETAINED COIN

A - SEALANT JOINTS ABOUT 1 IN WIDE

SEALED JOINTS IN SECTION

B - SEALANT CONTAIN BUBBLES

Figure 25. Six-month field evaluation - area 1 section 21

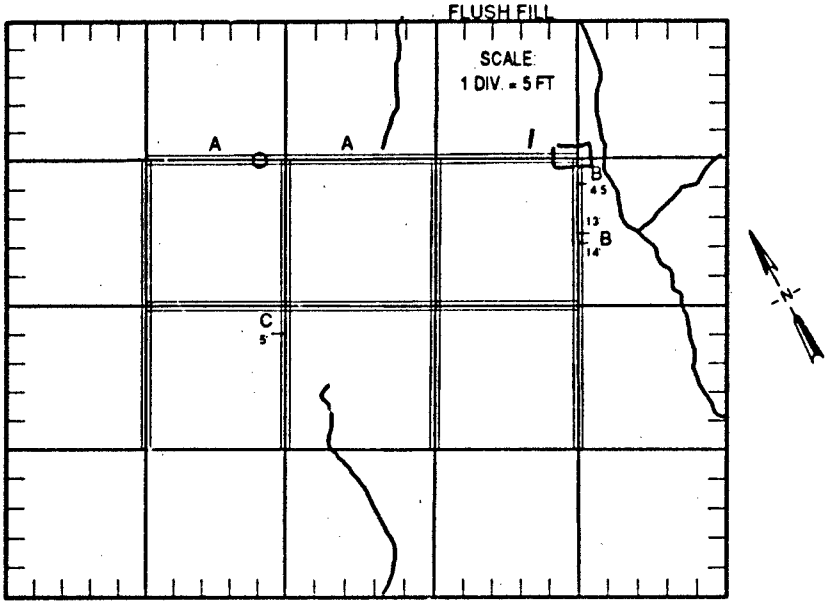
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 22 JOINT WIDTH: SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: CRAFCO IMPROVED NON-JFR, FLUSH FILL



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐	<11%	☐	<11%	☐	<11%	☐	<11%
FREQUENT	☐	11-50%	☐	11-50%	☐	11-50%	☐	11-50%
EXTENSIVE	☐	>50%	☐	>50%	☐	>50%	☐	>50%
COMPLETE	☐	100%	☐	100%	☐	100%	☐	100%

REMARKS: SURFACE BUBBLING OVER ALL JOINTS

O - SEALANT RETAIN COIN

A - SEALANT HAS SURFACE CRACKING

B - SNOW PLOW ABRASION ON SEALANT

SEALED JOINTS IN SECTION

C - SMALL AGGREGATE PULL AWAY FROM PAVEMENT ALLOWING MOISTURE IN

Figure 26. Six-month field evaluation - area 1 section 22

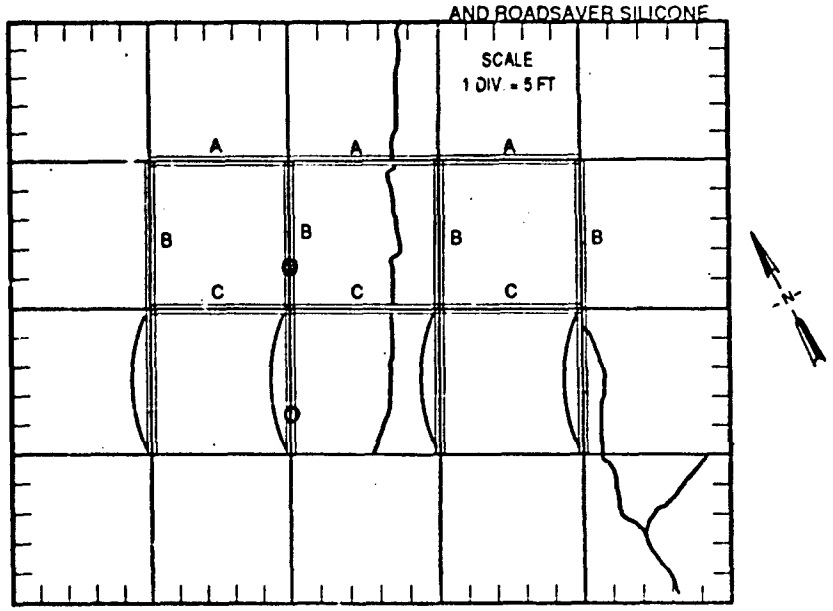
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 23 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY SIX MONTH EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JANUARY 22, 1992 SEALANT MATERIAL CRAFCO IMPROVED NON-JFR, AND ROADSAVER SILICONE



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS: A - BUBBLES (1/4 IN. DIAMETER) DOWN TO BACKER ROD, A, B & C - CONSIDERABLE BUBBLING IN SEALANT, 8-10 PER FOOT OF SEALANT.

O - SEALANT (CRAFCO ROADSAVER SILICONE) REJECTED COIN

⌒ - JOINTS WITH CRAFCO ROADSAVER SILICONE SEALANT

⊗ - SEALANT (CRAFCO IMPROVED NON-JFR) RETAINED COIN

═══ SEALED JOINTS IN SECTION

Figure 27. Six-month field evaluation - area 1 section 23

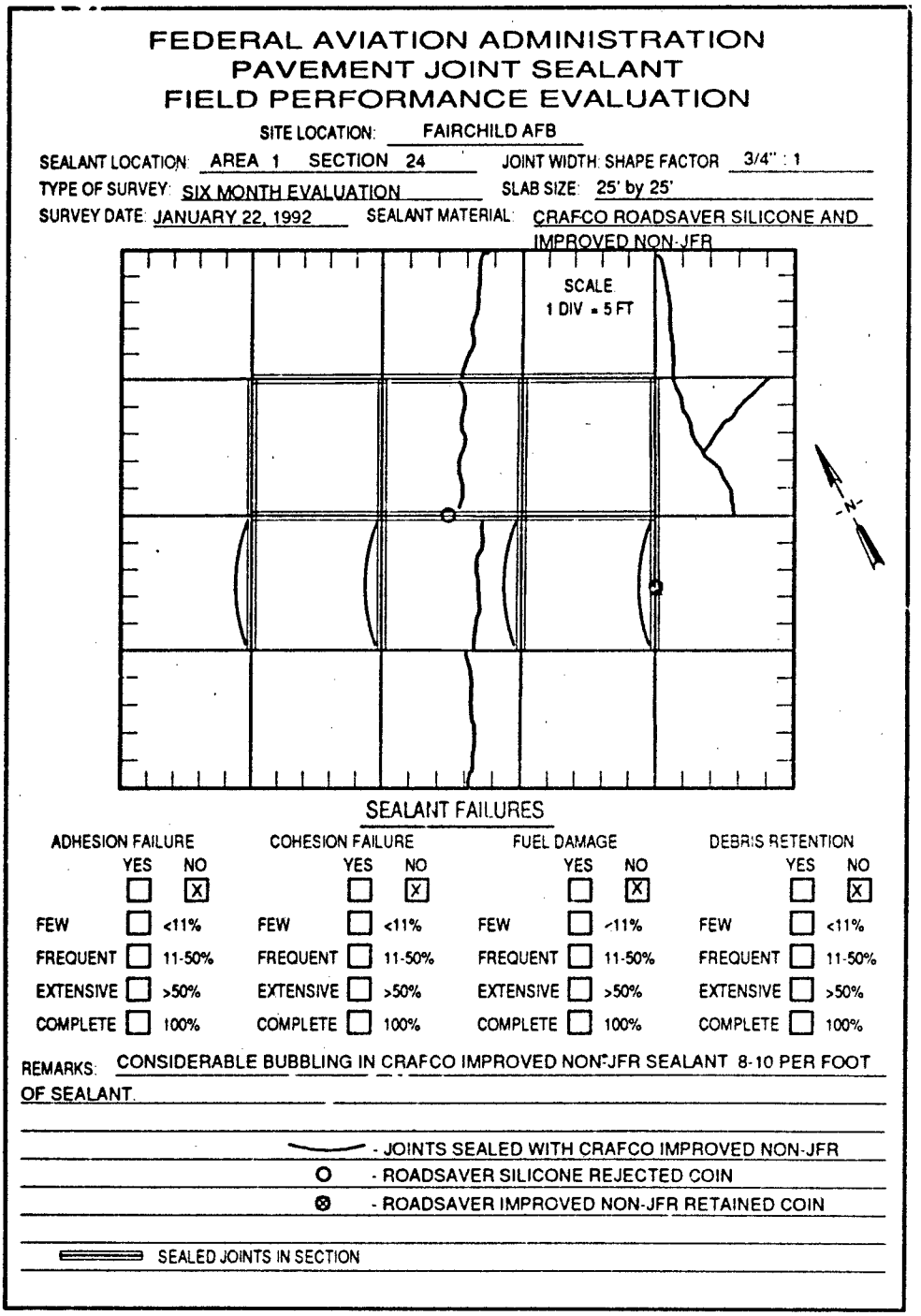


Figure 28. Six-month field evaluation - area 1 section 24

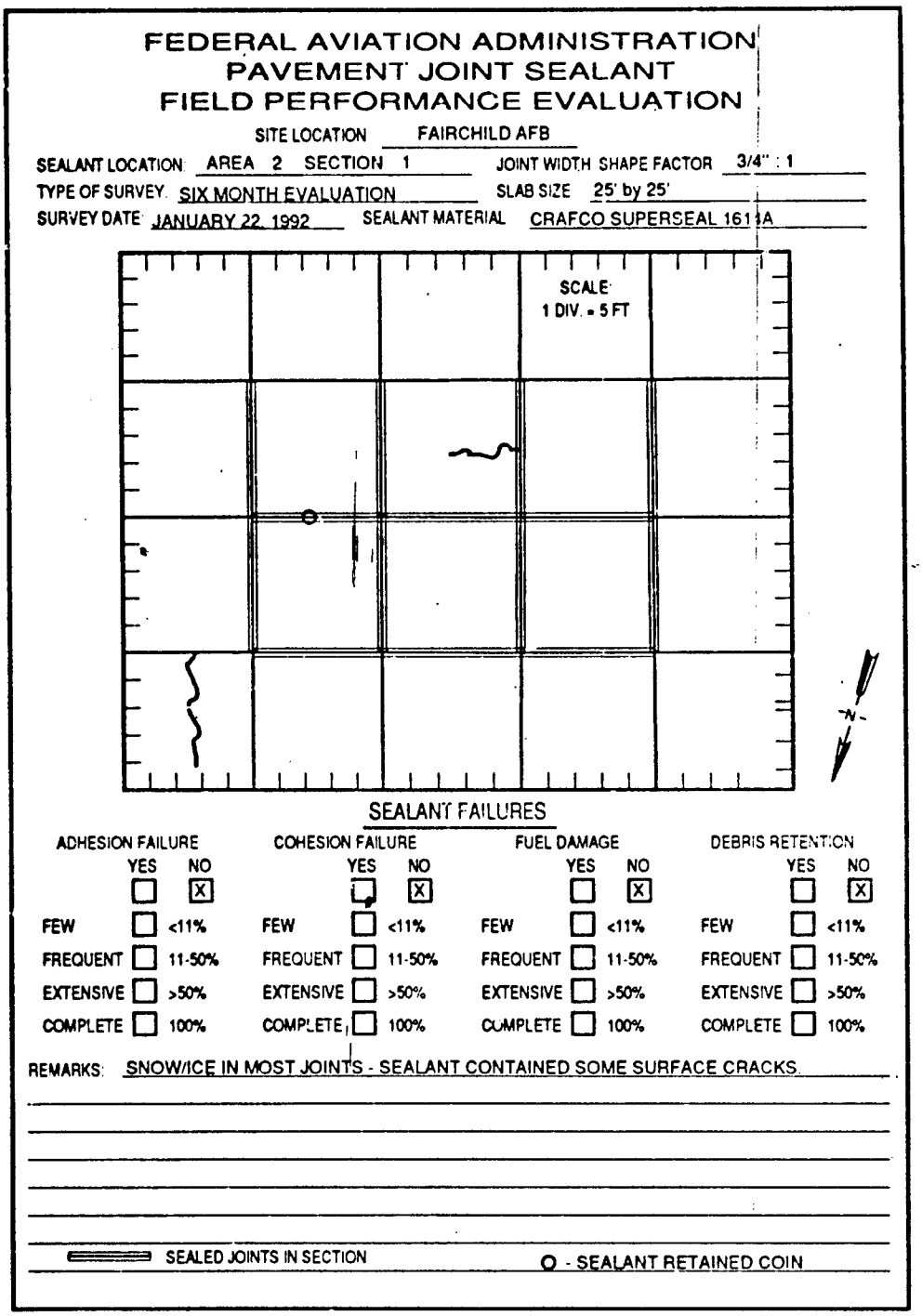


Figure 29. Six-month field evaluation - area 2 section 1

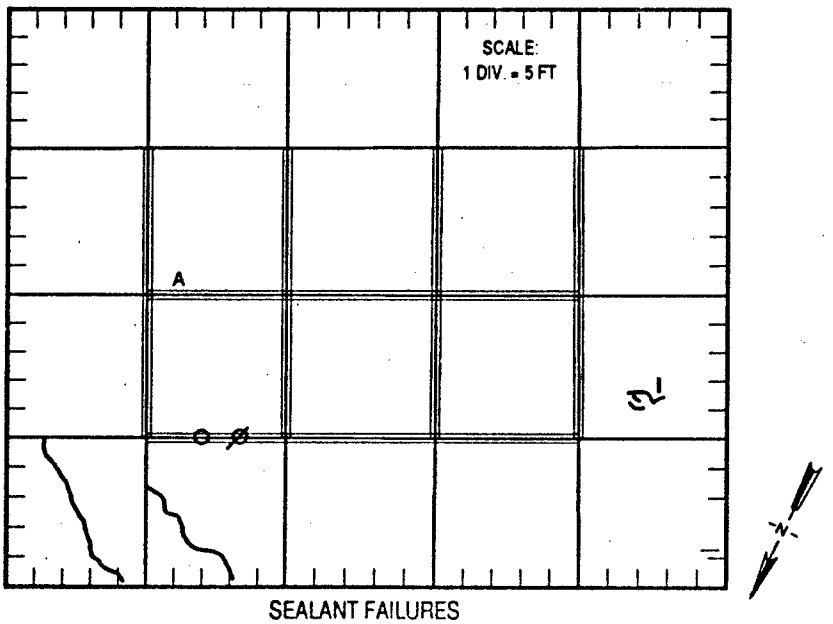
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 2 SECTION 2 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: CRAFCO IMPROVED JFR



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS: MOST JOINTS WERE COVERED WITH SNOW AND ICE - SURFACE CRACKS CONTAINED IN MOST SEALANT JOINTS.

O - SEALANT REJECTED COIN

Ø - SEALANT RETAINED COIN

SEALED JOINTS IN SECTION

A - BUBBLES IN SEALANT MATERIAL IN THIS JOINT

Figure 30. Six-month field evaluation - area 2 section 2

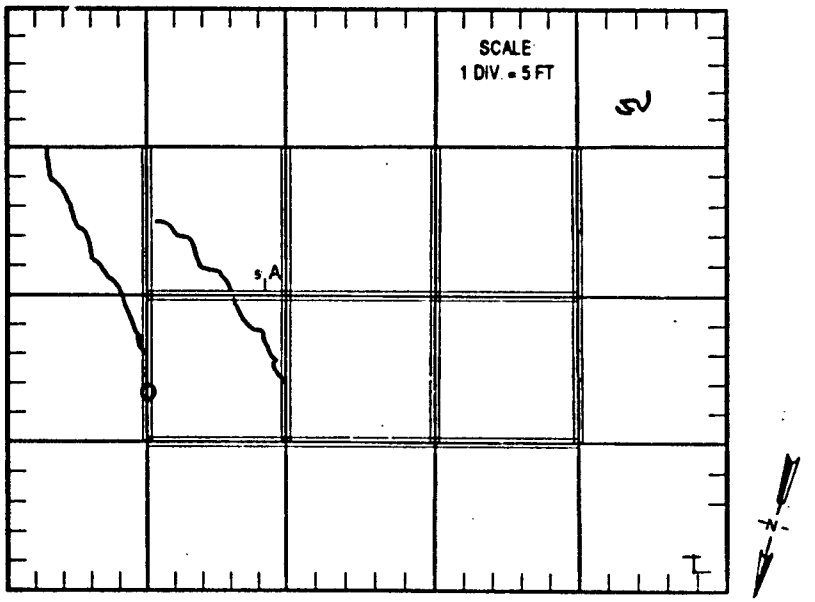
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION: AREA 2 SECTION 3 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL KOCH PRODUCT 9050 SL



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS ICE AND SNOW IN MOST JOINTS

SEALED JOINTS IN SECTION

O - SEALANT SLOWLY REJECTED COIN

Figure 31. Six-month field evaluation - area 2 section 3

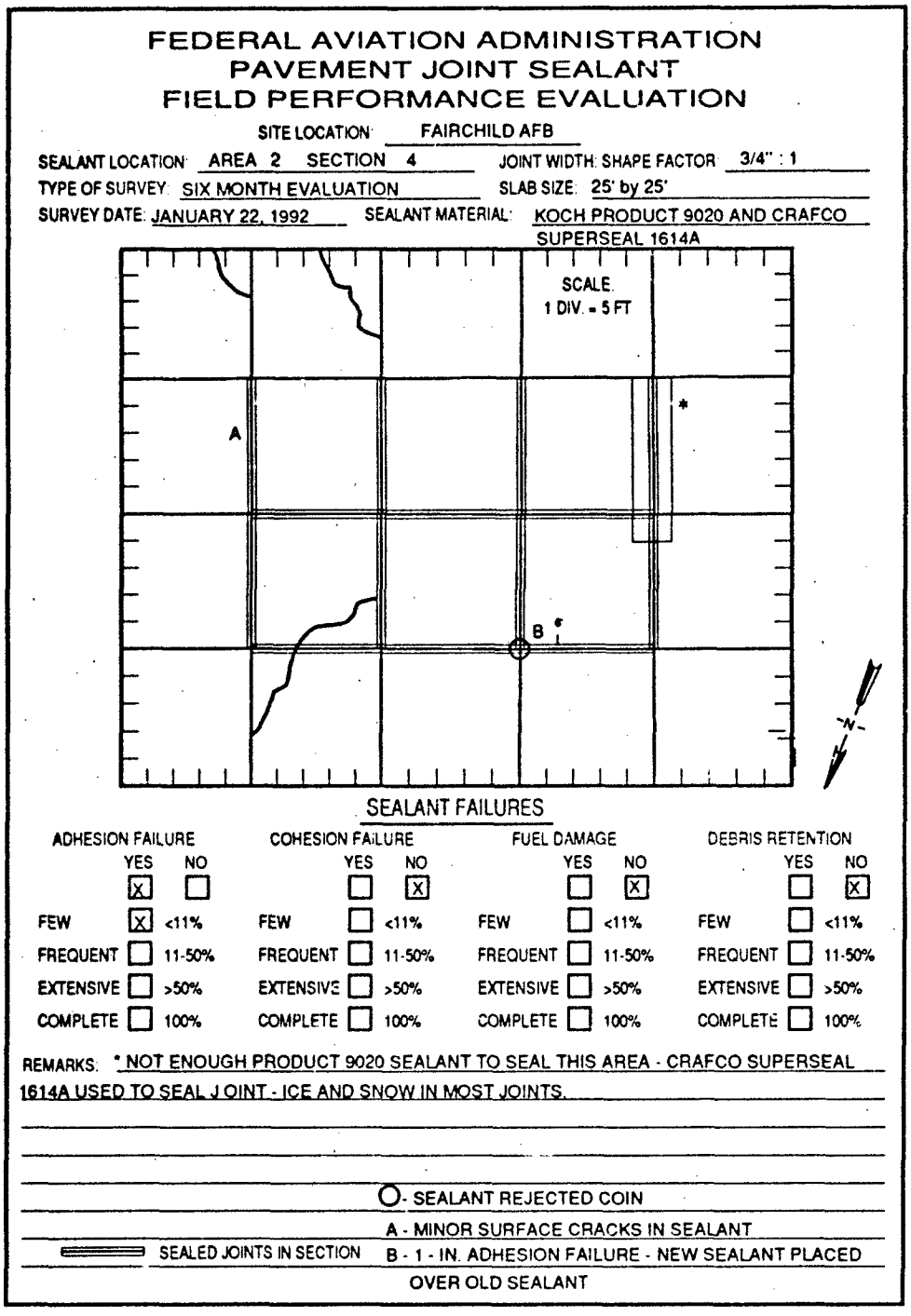


Figure 32. Six-month field evaluation - area 2 section 4

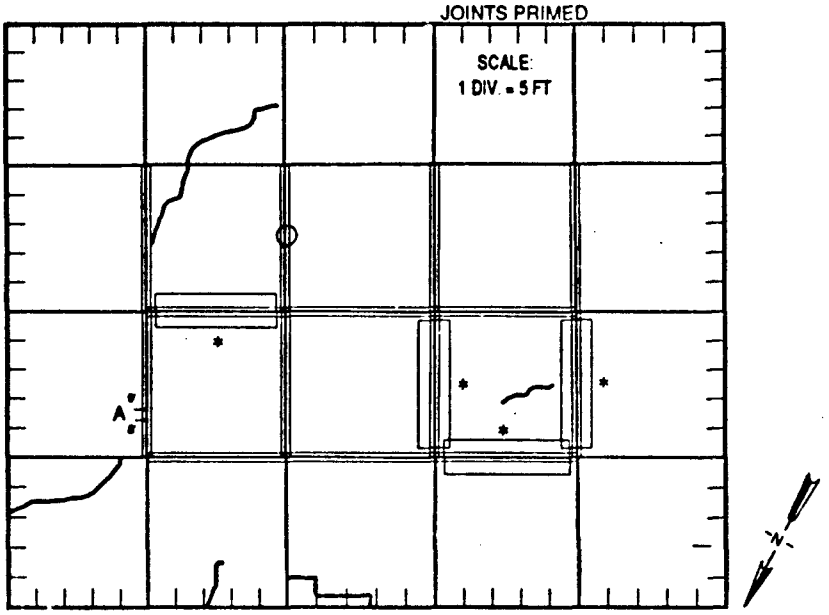
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 2 SECTION 5 JOINT WIDTH: SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: KOCH PRODUCT 9012/SELECTED JOINTS PRIMED



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS: ICE AND SNOW IN MOST JOINTS.

* - JOINTS PRIMED

○ - SEALANT SLOWLY REJECTED COIN

═══ SEALED JOINTS IN SECTION

A - SURFACE BUBBLING IN SEALANT

Figure 33 Six-month field evaluation - area 2 section 5

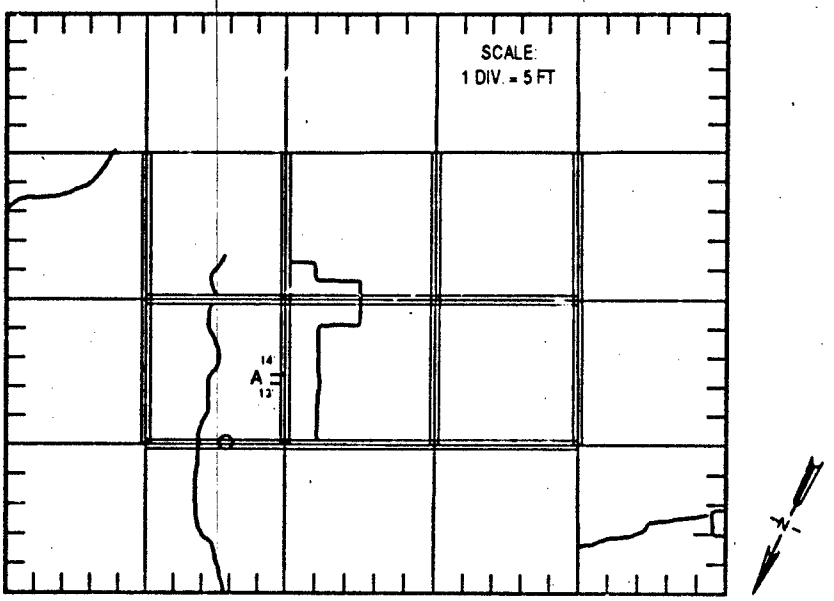
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 2 SECTION 6 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: SIX MONTH EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JANUARY 22, 1992 SEALANT MATERIAL: CRAFCO SUPERSEAL 1614A



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X <11%		FEW	<11%	FEW	<11%	FEW	<11%
FREQUENT	11-50%		FREQUENT	11-50%	FREQUENT	11-50%	FREQUENT	11-50%
EXTENSIVE	>50%		EXTENSIVE	>50%	EXTENSIVE	>50%	EXTENSIVE	>50%
COMPLETE	100%		COMPLETE	100%	COMPLETE	100%	COMPLETE	100%

REMARKS: ICE AND SNOW IN SOME JOINTS- SURFACE CRACKING PRESENT IN SEALANT JOINTS.

O - SEALANT RETAINED COIN

SEALED JOINTS IN SECTION

A - ADHESION FAILURE

Figure 34. Six-month field evaluation - area 2 section 6

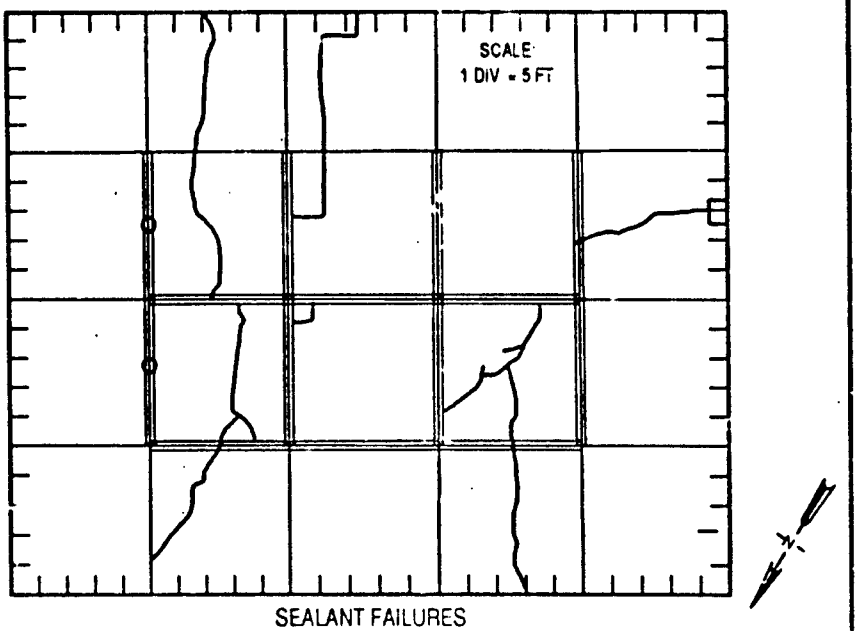
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 2 SECTION 7 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY SIX MONTH EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JANUARY 22, 1992 SEALANT MATERIAL CRAFCO IMPROVED JER



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11 50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS ICE IN MOST JOINTS

SEALED JOINTS IN SECTION

O - SEALANT SLOWLY REJECTED COIN

Figure 35. Six-month field evaluation - area 2 section 7

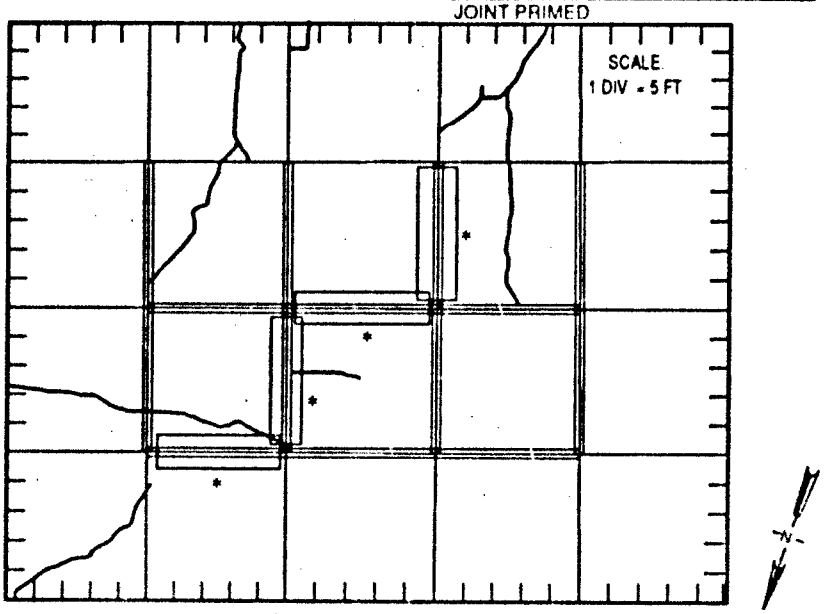
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 2 SECTION 8 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY SIX MONTH EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JANUARY 22, 1992 SEALANT MATERIAL KOCH PRODUCT 9012/SELECTED JOINT PRIMED



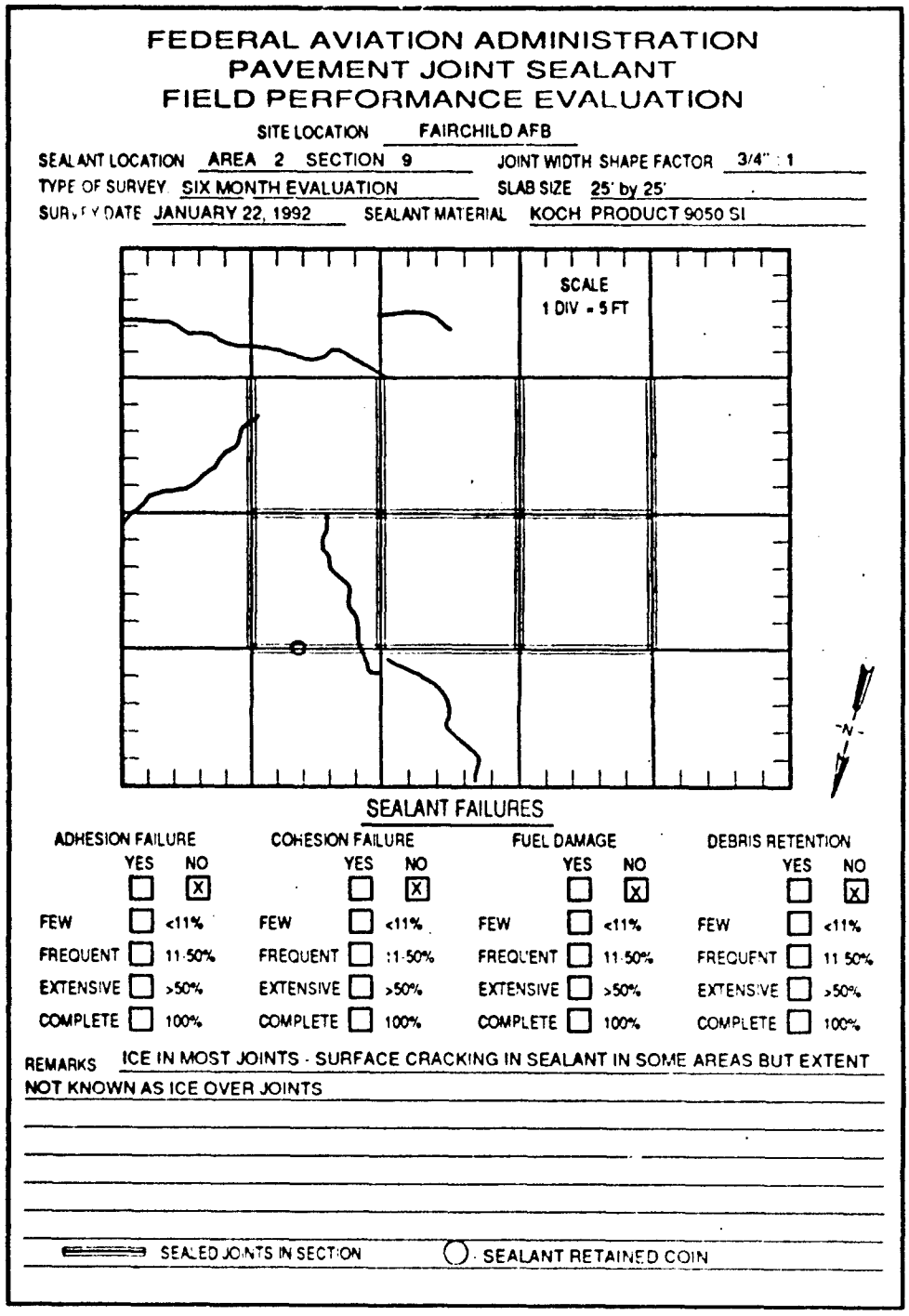
SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES ☐	NO ☒	YES ☐	NO ☒	YES ☐	NO ☒	YES ☐	NO ☒
FEW	☐	<11%	☐	<11%	☐	<11%	☐	<11%
FREQUENT	☐	11-50%	☐	11-50%	☐	11-50%	☐	11-50%
EXTENSIVE	☐	>50%	☐	>50%	☐	>50%	☐	>50%
COMPLETE	☐	100%	☐	100%	☐	100%	☐	100%

REMARKS COIN COULD NOT BE INSERTED IN SEALANT - ICE IN MOST JOINTS - SURFACE CRACKING IN SEALANT IN SOME JOINTS - SURFACE BUBBLING IN SEALANT

SEALED JOINTS IN SECTION * JOINTS PRIMED BEFORE POURING

Figure 36. Six-month field evaluation - area 2 section 8



FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 2 SECTION 9 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY SIX MONTH EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JANUARY 22, 1992 SEALANT MATERIAL KOCH PRODUCT 9050 SI

SCALE
1 DIV = 5 FT

N

SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		FEW ☐ <11%		FEW ☐ <11%		FEW ☐ <11%	
FREQUENT	☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%	
EXTENSIVE	☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%	
COMPLETE	☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%	

REMARKS ICE IN MOST JOINTS - SURFACE CRACKING IN SEALANT IN SOME AREAS BUT EXTENT NOT KNOWN AS ICE OVER JOINTS

SEALED JOINTS IN SECTION ○ SEALANT RETAINED COIN

Figure 37. Six-month field evaluation - area 2 section 9

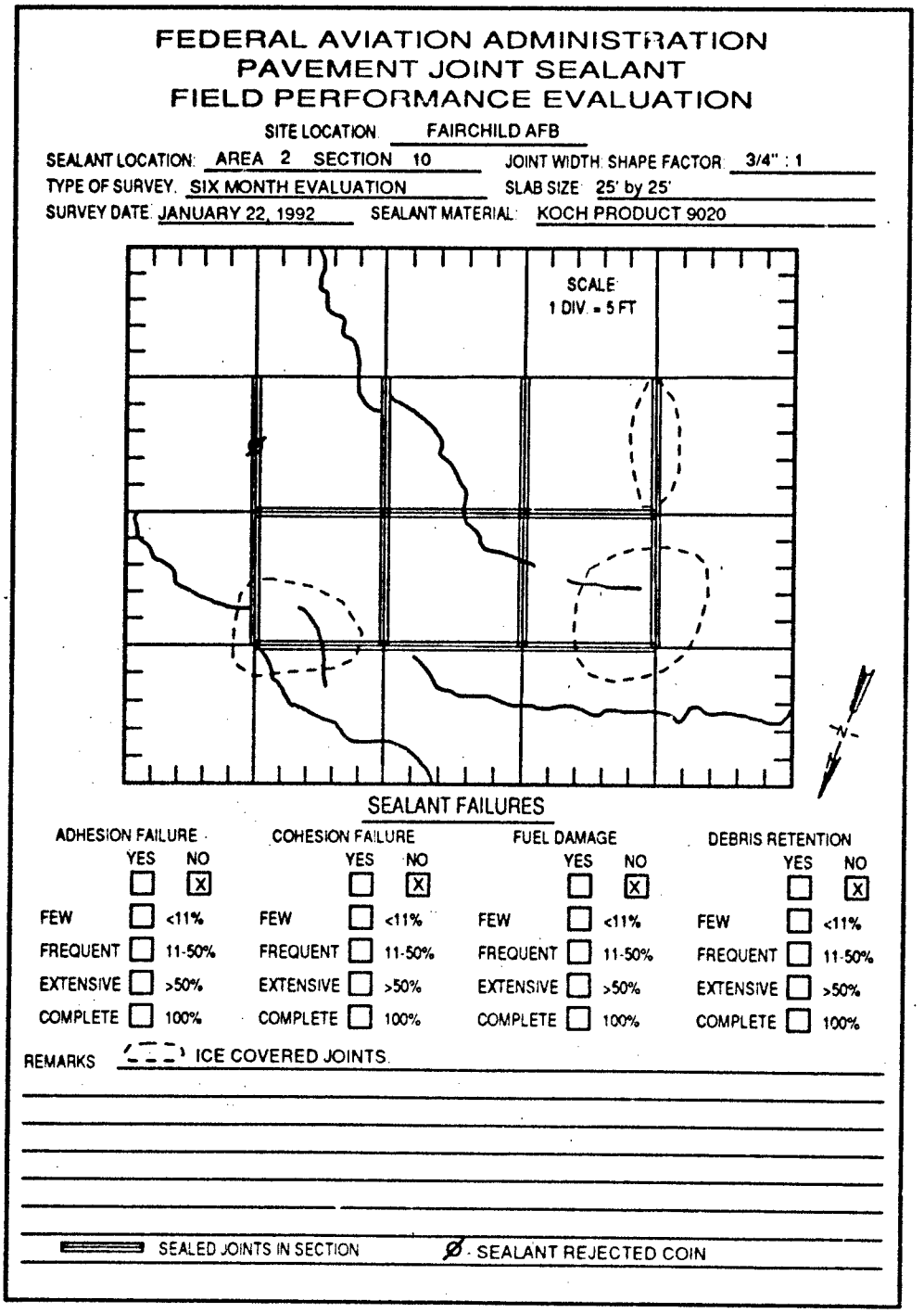


Figure 38. Six-month field evaluation - area 2 section 10

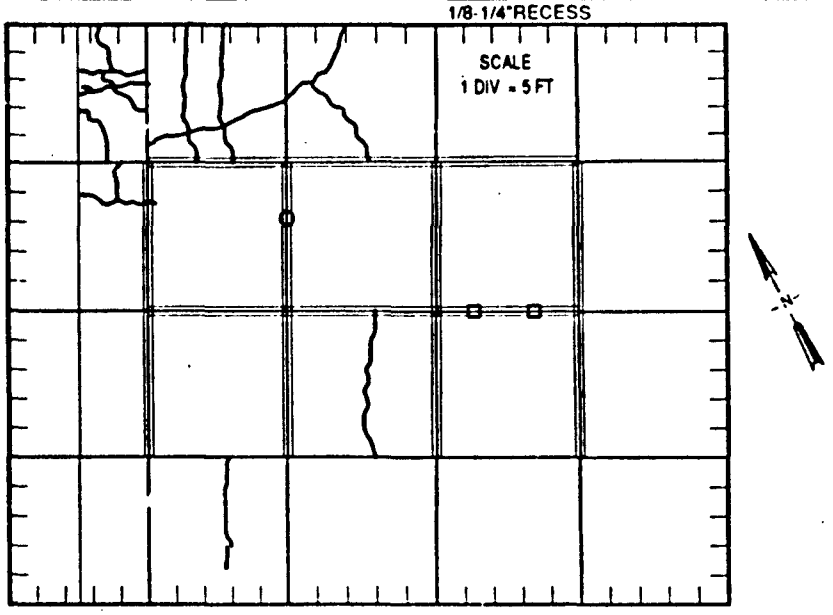
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 1 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL CRAFCO ROADSAVER 222 WITH 1/8-1/4"RECESS



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X <11%		FEW ☐ <11%		FEW ☐ <11%		FEW ☐ <11%	
FREQUENT	☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%	
EXTENSIVE	☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%	
COMPLETE	☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%	

REMARKS ☐ - TOTAL OF 1 FOOT ADHESION FAILURE, 0-SEALANT RETAINED COIN HOWEVER IT APPEARED ELASTIC, SEALANT CONTAINED FEW BUBBLES WITH DIAMETER GREATER THAN 1/8", NO SWELLING

BUBBLE RATING - NO OF BUBBLES - 1

BUBBLE SIZE - 1

SWELLING - 0

2

SEALED JOINTS IN SECTION

OVERALL RATING = 2/3 = 0 7

Figure 39. One-year field evaluation - area 1 section 1

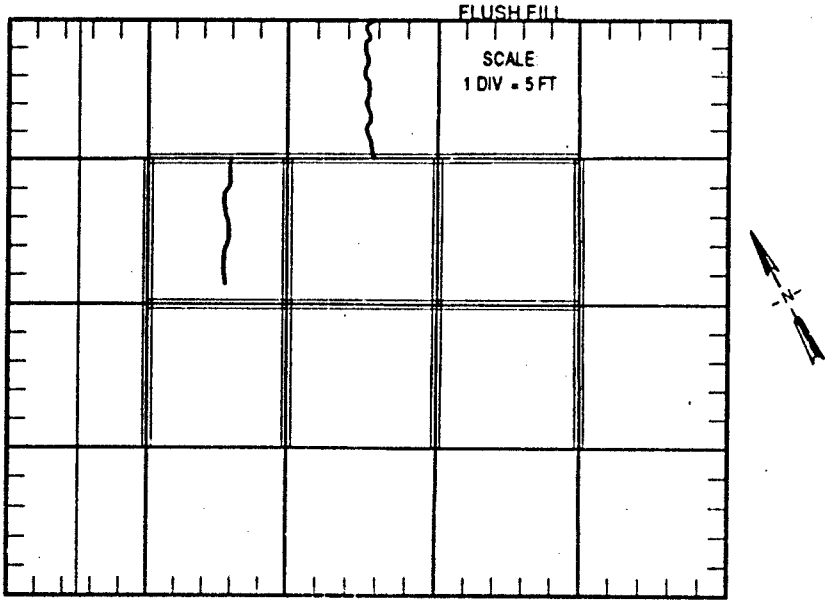
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 2 JOINT WIDTH: SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL CRAFCO ROADSAVER 222, FLUSH FILL



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐	<11%	☐	<11%	☐	<11%	☐	<11%
FREQUENT	☐	11-50%	☐	11-50%	☐	11-50%	☐	11-50%
EXTENSIVE	☐	>50%	☐	>50%	☐	>50%	☐	>50%
COMPLETE	☐	100%	☐	100%	☐	100%	☐	100%

REMARKS: LARGE NUMBER OF BUBBLES, UP TO 10 PER FOOT OF SEALANT, BUBBLE DIAMETER WAS GREATER THAN 1/8 IN. IN DIAMETER, CONSIDERABLE SWELLING OF SEALANT, SOME AREAS SEALANT DAMAGED BY SNOW PLOW DURING WINTER

BUBBLE RATING - NO. OF BUBBLES = 2

BUBBLE SIZE = 3

SWELLING = 2

SEALED JOINTS IN SECTION

7

OVERALL RATING = 7/3 = 2.33

Figure 40. One-year field evaluation - area 1 section 2

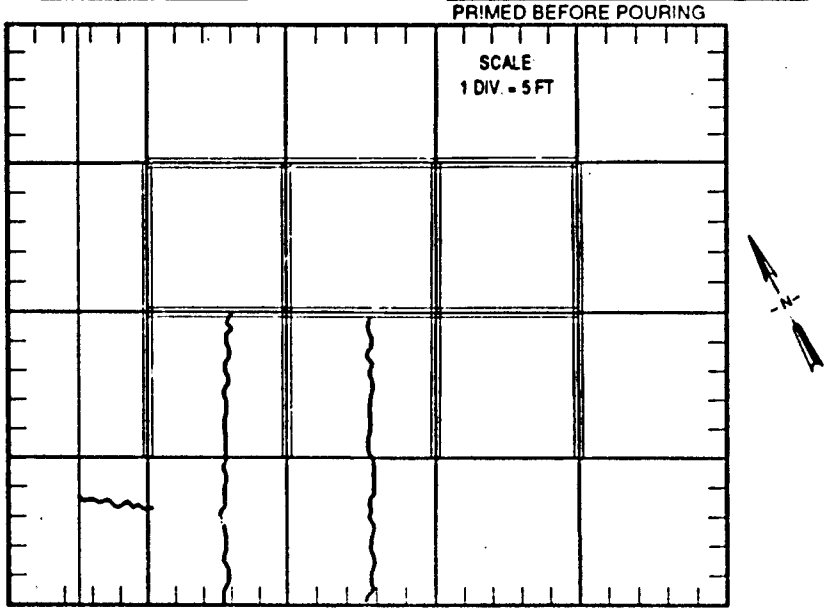
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 3 JOINT WIDTH SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25 (EXCEPT AS SHOWN)

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: CRAFCO ROADSAVER 222 JOINTS PRIMED BEFORE POURING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[ ]	[X]	[ ]	[X]
FEW	[X] <11%		[ ] <11%		[ ] <11%		[ ] <11%	
FREQUENT	[ ] 11-50%		[ ] 11-50%		[ ] 11-50%		[ ] 11-50%	
EXTENSIVE	[ ] >50%		[ ] >50%		[ ] >50%		[ ] >50%	
COMPLETE	[ ] 100%		[ ] 100%		[ ] 100%		[ ] 100%	

REMARKS: SEALANT HAS PULLED AWAY FROM PCC, APPROXIMATELY 1/16-1/8 IN., BUBBLES 6 PER FOOT OF SEALANT WITH A DIAMETER GREATER THAN 1/4 IN., SEALANT RETAINED THE COIN, SWELLING APPROXIMATELY 1/4 INCH

BUBBLE RATING - NO. OF BUBBLES = 2

BUBBLE SIZE = 3

SWELLING = 2

SEALED JOINTS IN SECTION 7

OVERALL RATING = 7/3 = 2.33

Figure 41. One-year field evaluation - area 1 section 3

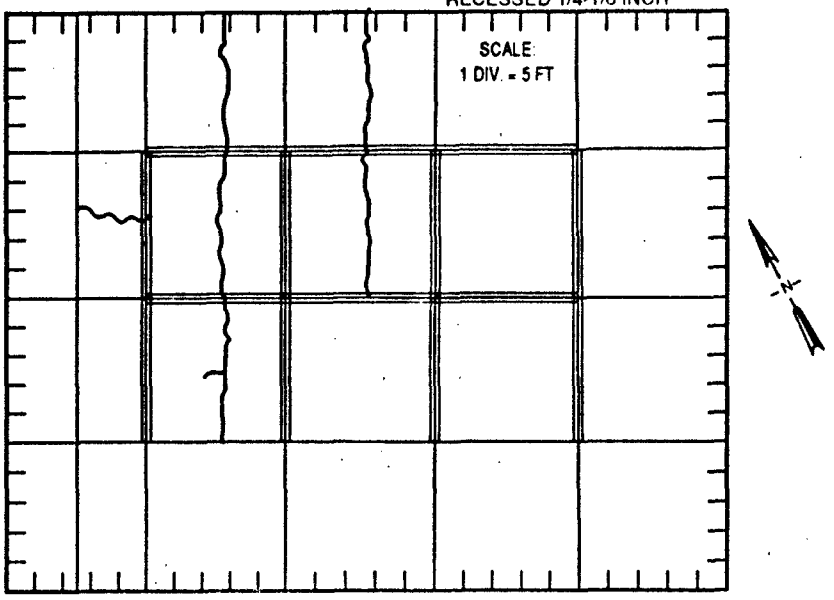
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 4 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: CRAFCO IMPROVED NON-JFR, RECESSED 1/4-1/8 INCH



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS: NUMBER OF BUBBLES VARIED FROM 2-4 PER FOOT OF SEALANT AND HAD A DIAMETER GREATER THAN 1/4 INCH; SEALANT SURFACE SEPARATED 1/16-1/8 INCH, SEALANT REJECTED COIN.

BUBBLE RATING - NO OF BUBBLES = 1

BUBBLE SIZE = 3

SWELLLING = 2

SEALED JOINTS IN SECTION 6

OVERALL RATING = 6/3 = 2

Figure 42. One-year field evaluation - area 1 section 4

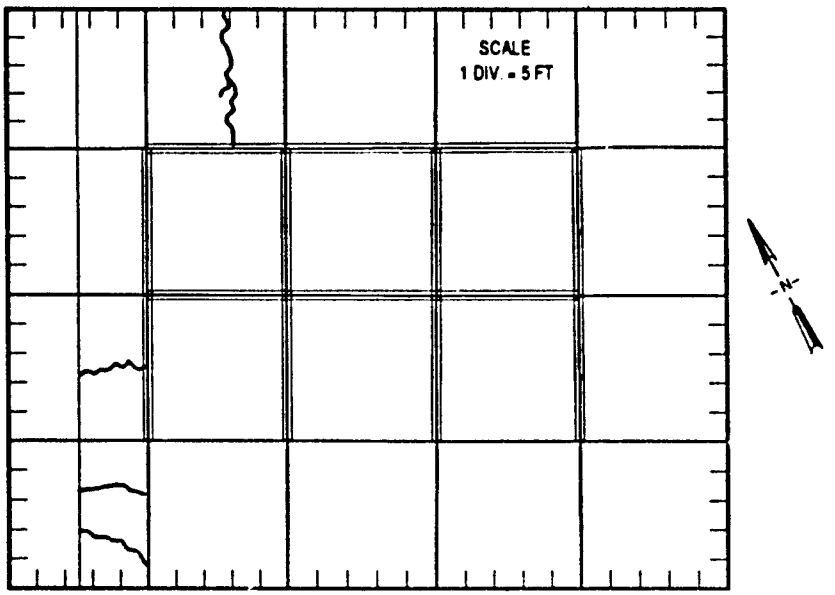
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 5 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL CRAFCO IMPROVED NON-JFR



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X <11%		FEW ☐ <11%		FEW ☐ <11%		FEW ☐ <11%	
FREQUENT	☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%	
EXTENSIVE	☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%	
COMPLETE	☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%	

REMARKS BUBBLES FROM 1-2 PER FOOT WERE PRESENT WITH SOME BUBBLES HAVING A DIAMETER GREATER THAN 1/4 IN., SOME SWELLING ALONG WITH SURFACE CRACKS IN THE SEALANT. NO INCREASE IN ADHESION FAILURE FROM THE 6 MO. EVALUATION. THE ADHESION FAILURE WAS NOT AS APPARENT WITH THE JOINTS CLOSED.

BUBBLE RATING - NO. OF BUBBLES = 3

BUBBLE SIZE = 3

SWELLING = 0

SEALED JOINTS IN SECTION 6

OVERALL RATING = 6/3 = 2

Figure 43. One-year field evaluation - area 1 section 5

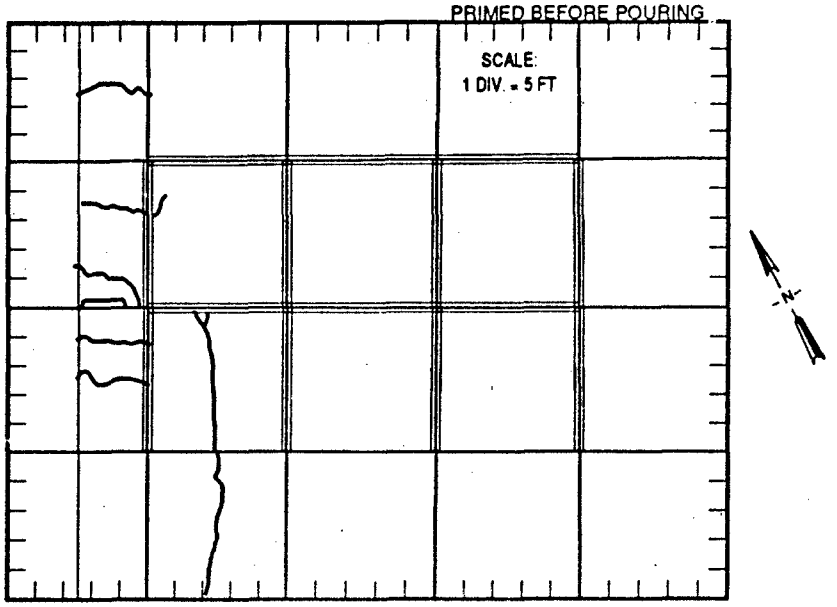
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 6 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: CRAFCO IMPROVED NON-JFR JOINTS PRIMED BEFORE POURING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X <11%		FEW	<11%	FEW	<11%	FEW	<11%
FREQUENT	11-50%		FREQUENT	11-50%	FREQUENT	11-50%	FREQUENT	11-50%
EXTENSIVE	>50%		EXTENSIVE	>50%	EXTENSIVE	>50%	EXTENSIVE	>50%
COMPLETE	100%		COMPLETE	100%	COMPLETE	100%	COMPLETE	100%

REMARKS BUBBLES PER FOOT RANGED FROM 2-5 WITH A DIAMETER GREATER THAN 1/4 IN., 1/16 IN. - 1/8 IN. SEALANT SEPARATION FROM PCC IN MANY AREAS, SOME SWELLING GREATER THAN 1/4 IN. - NO INCREASE IN SEALANT SEPARATION FROM 6-MONTH EVALUATION.

BUBBLE RATING - NO. OF BUBBLES = 2

BUBBLE SIZE = 3

SWELLING = 3

SEALED JOINTS IN SECTION

OVERALL RATING = 8/3 = 2.67

Figure 44. One-year field evaluation - area 1 section 6

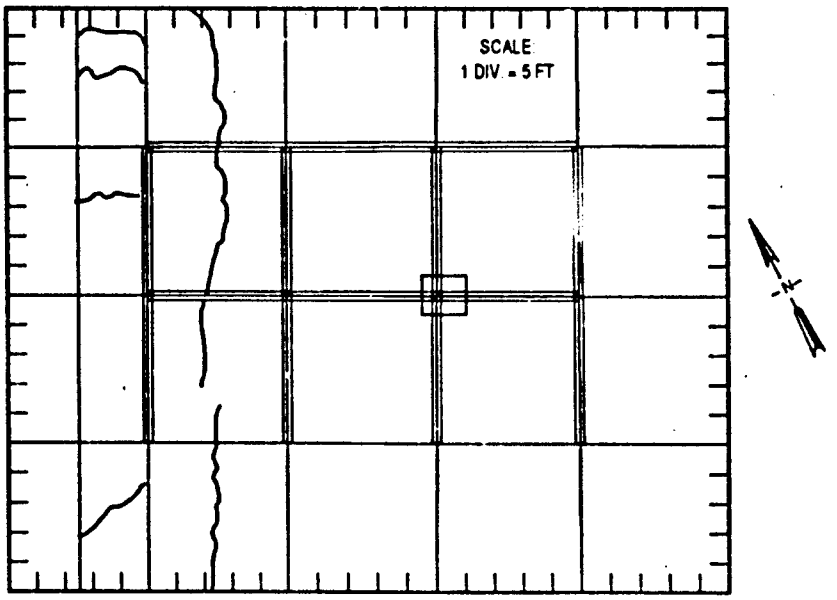
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 7 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: CRAFCO ROADSAVER SILICONE



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS: SEALANT REJECTED COIN, ☐ BACKER ROD FLOATED IN SEALANT, NO OTHER DEFECTS NOTED.

SEALED JOINTS IN SECTION

Figure 45. One-year field evaluation - area 1 section 7

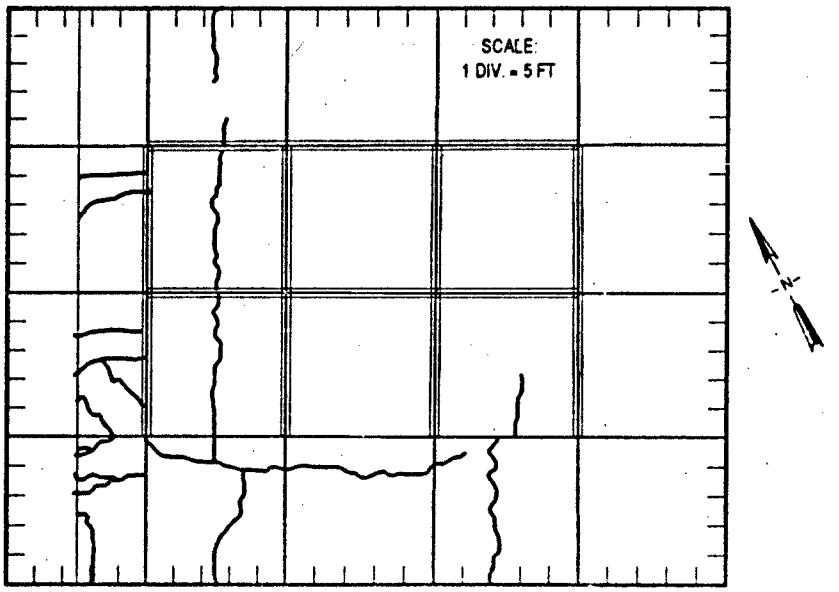
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 8 JOINT WIDTH SHAPE FACTOR 3/4" 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: MOBAY BAYSILONE 960



SEALANT FAILURES

ADHESION FAILURE	YES	NO	COHESION FAILURE	YES	NO	FUEL DAMAGE	YES	NO	DEBRIS RETENTION	YES	NO
	X				X			X			X
FEW	X	<11%	FEW		<11%	FEW		<11%	FEW		<11%
FREQUENT		11-50%	FREQUENT		11-50%	FREQUENT		11-50%	FREQUENT		11-50%
EXTENSIVE		>50%	EXTENSIVE		>50%	EXTENSIVE		>50%	EXTENSIVE		>50%
COMPLETE		100%	COMPLETE		100%	COMPLETE		100%	COMPLETE		100%

REMARKS: NO INCREASE IN SEALANT ADHESION FAILURE FROM 6-MONTH EVALUATION, SEALANT DISCOLORED IN AREAS WHERE OLD SEALANT NOT COMPLETELY REMOVED, SEALANT REJECTED COIN AND APPEARS TO HAVE HIGHER MODULUS THAN SELF LEVELING SEALANTS

SEALED JOINTS IN SECTION

Figure 46. One-year field evaluation - area 1 section 8

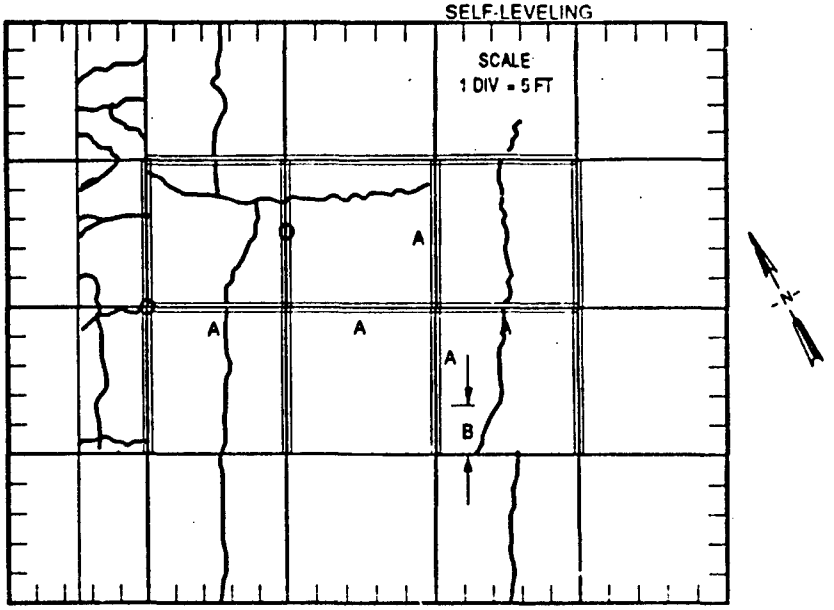
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 9 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL MOBAY BAYSILONE 960 SELF-LEVELING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X <11%		FEW	<11%	FEW	<11%	FEW	<11%
FREQUENT	11-50%		FREQUENT	11-50%	FREQUENT	11-50%	FREQUENT	11-50%
EXTENSIVE	>50%		EXTENSIVE	>50%	EXTENSIVE	>50%	EXTENSIVE	>50%
COMPLETE	100%		COMPLETE	100%	COMPLETE	100%	COMPLETE	100%

REMARKS O -1/16 IN. SEPARATION OF SEALANT FROM CONCRETE, SEALANT REJECTED COIN. SEALANT DISCOLORATION IN AREA WHERE OLD SEALANT NOT COMPLETELY REMOVED FROM JOINT. A - SEALANT SWELLING 1/8-1/4 IN. B - 1/8" DIAMETER BUBBLES (SURFACE) FOR APPROXIMATELY 4 FT., 10-15 BUBBLES IN THIS AREA

BUBBLE RATING - NO. OF BUBBLES - 1

BUBBLE SIZE - 1

SWELLING - 2

SEALED JOINTS IN SECTION 4

OVERALL RATING = 4/3 = 1.33

Figure 47. One-year field evaluation - area 1 section 9

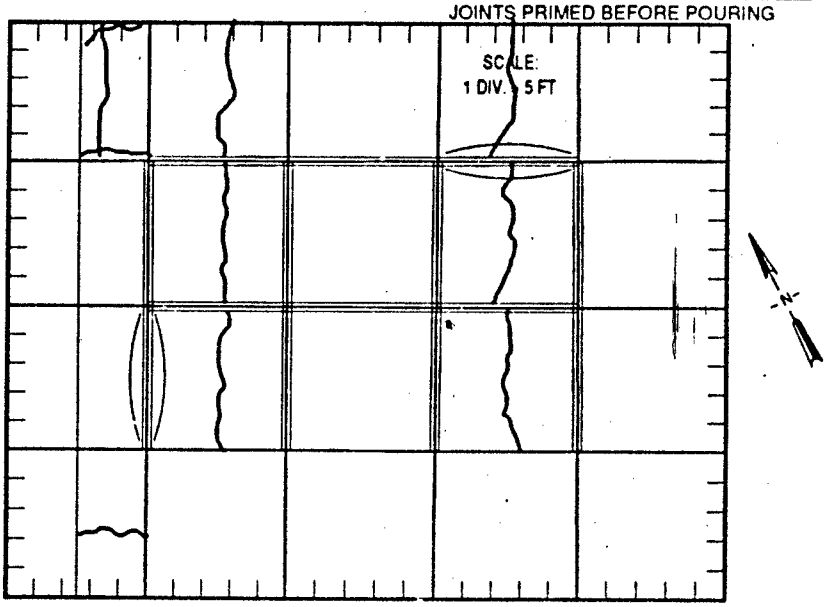
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 10 JOINT WIDTH: SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS NOTED)

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: KOCH PRODUCT 9005 WITH SELECTED JOINTS PRIMED BEFORE POURING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[ ]	[X]	[ ]	[X]
FEW	[X] <11%		FEW [ ] <11%		FEW [ ] <11%		FEW [ ] <11%	
FREQUENT	[ ] 11-50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%	
EXTENSIVE	[ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%	
COMPLETE	[ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%	

REMARKS: SEALANT RETAINED COIN, BUBBLES 1/8-1/4 IN. IN DIAMETER, AVERAGED ABOUT 5 PER FOOT OF SEALANT. SELANT SEPARATION FROM CONCRETE APPROXIMELY 1/8 IN., SOME SURFACE CRACKING, NO INCREASE IN ADHESION FAILURE FROM 6 MONTH EVALUATION

JOINTS PRIMED BEFORE POURING

BUBBLE RATING - NO OF BUBBLES - 2

BUBBLES SIZE - 2

SEALED JOINTS IN SECTION

SWELLING - 0

OVERALL RATING = 4/3 = 1 33

Figure 48. One-year field evaluation - area 1 section 10

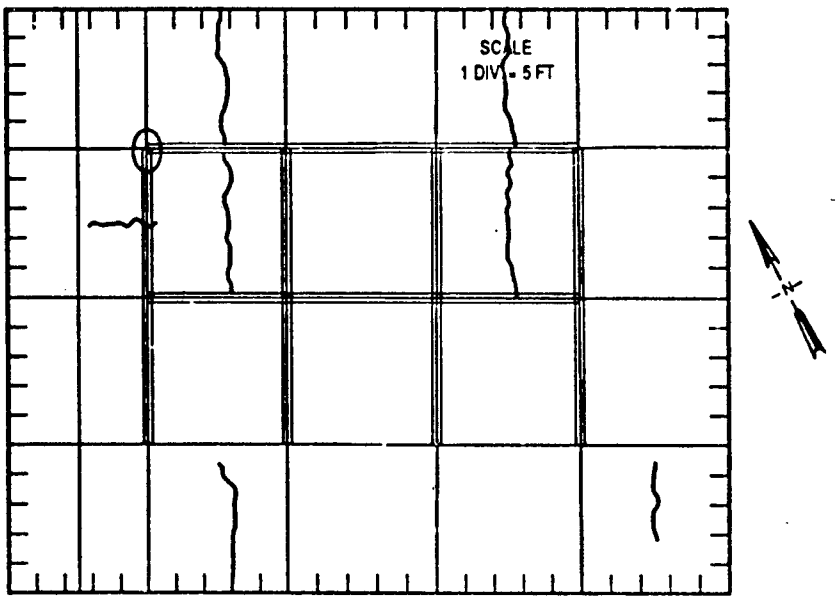
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 11 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL DOW CORNING 902 RCS



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS SEALANT REJECTED COIN, SOME SEALANT DISCOLORATION.
O - NO BACKER ROD OR SEALANT HAS SUNK INTO JOINT

SEALED JOINTS IN SECTION

Figure 49. One-year field evaluation - area 1 section 11

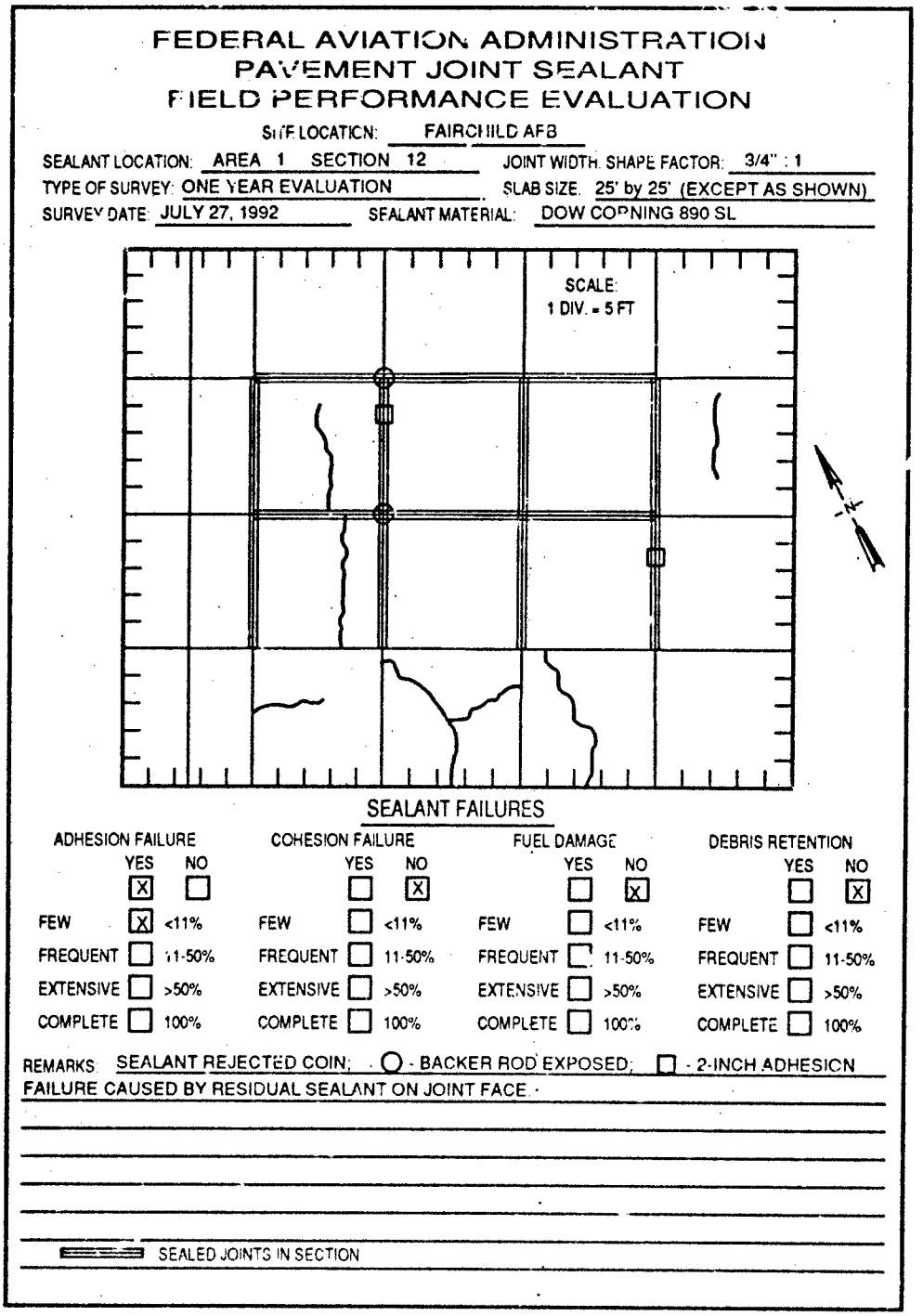


Figure 50. One-year field evaluation - area 1 section 12

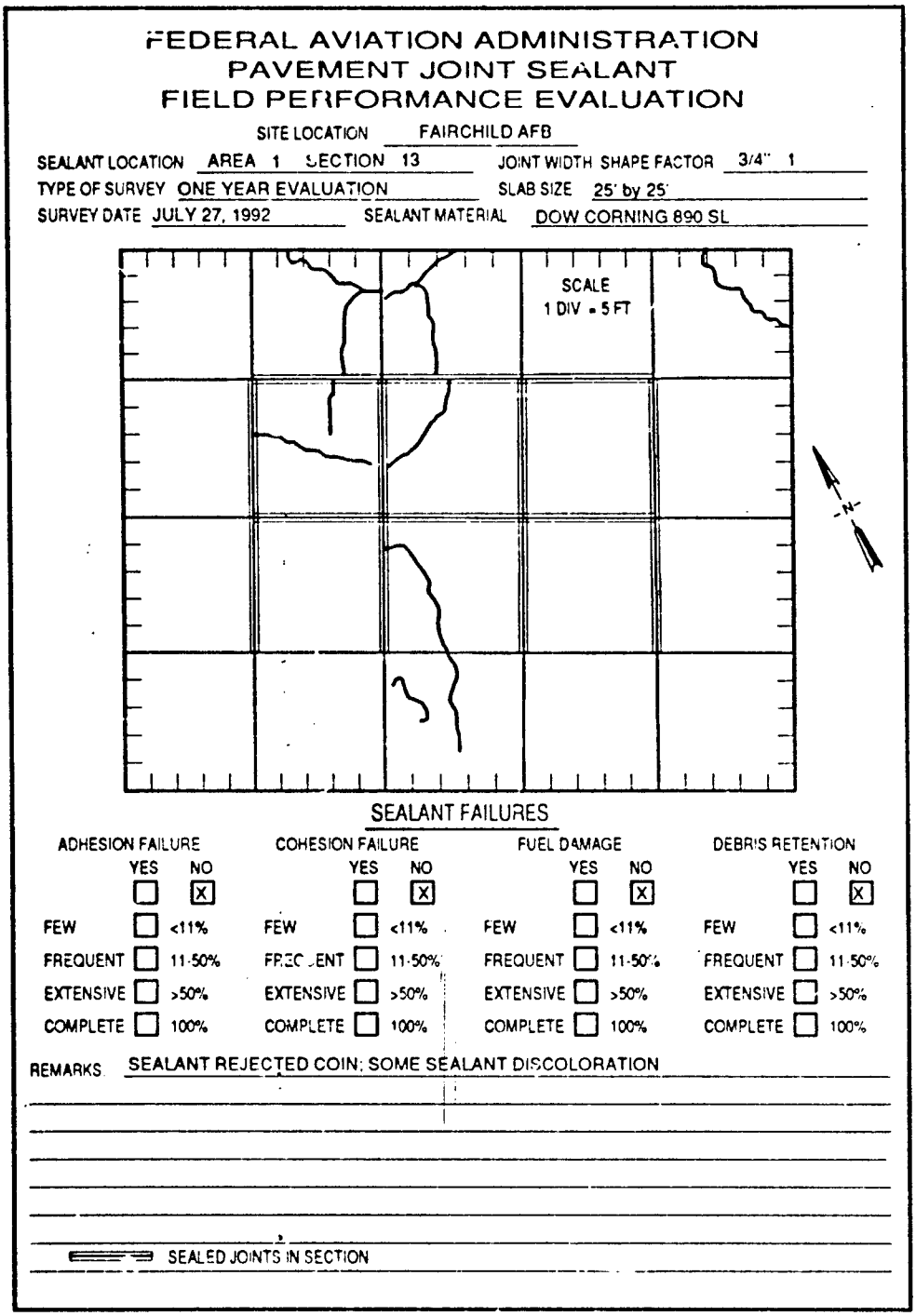


Figure 51. One-year field evaluation - area 1 section 13

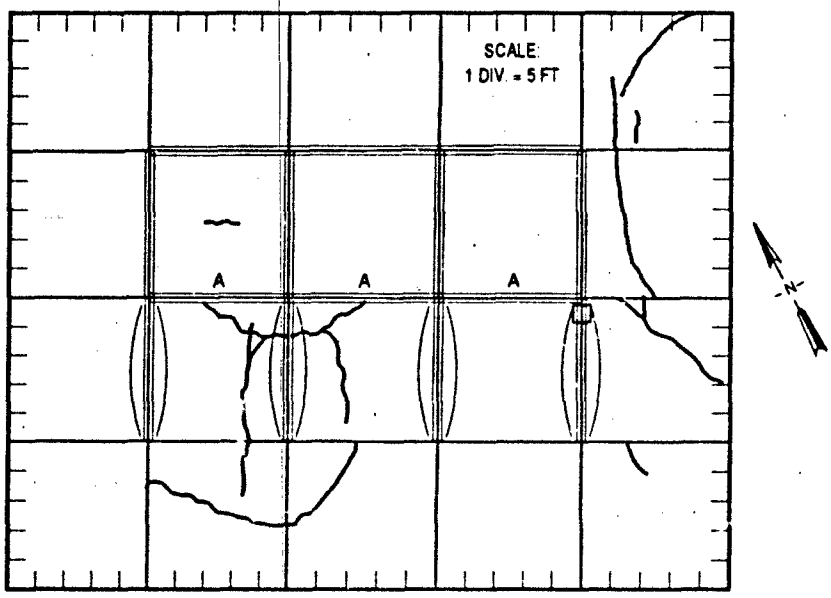
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 14 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27,1992 SEALANT MATERIAL: DOW CORNING 902 RCS AND 890 SL



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[ ]	[X]	[ ]	[X]
FEW	[X] <11%		FEW [ ] <11%		FEW [ ] <11%		FEW [ ] <11%	
FREQUENT	[ ] 11 50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%	
EXTENSIVE	[ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%	
COMPLETE	[ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%	

REMARKS: [ ] - 2-INCH ADHESION FAILURE, SEALANT REJECTED COIN, ( ) JOINTS, SEALED WITH DOW CORNING 890 SL, A - ONE BUBBLE PER FOOT, 1/8 IN. DIAMETER

BUBBLE RATING - NO. OF BUBBLES - 1

BUBBLE SIZE - 1

SWELLING - 0

SEALED JOINTS IN SECTION

OVERALL RATING 2/3 = 0.66

Figure 52. One-year field evaluation - area 1 section 14

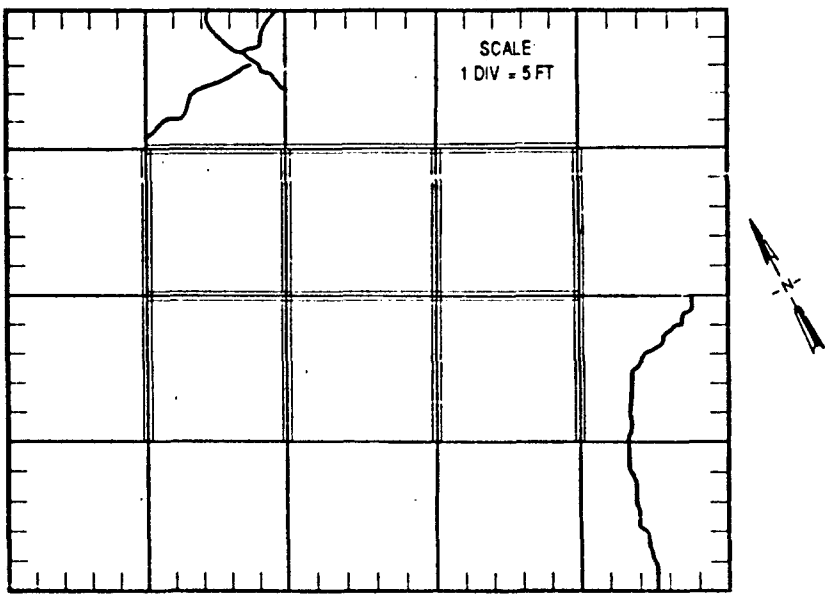
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 15 JOINT WIDTH SHAPE FACTOR 3/4" 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: MOBAY BAYSILONE 960 SL



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS: SEALANT REJECTED COIN, SOME SEALANT DISCOLORATION.

SEALED JOINTS IN SECTION

Figure 53. One-year field evaluation - area 1 section 15

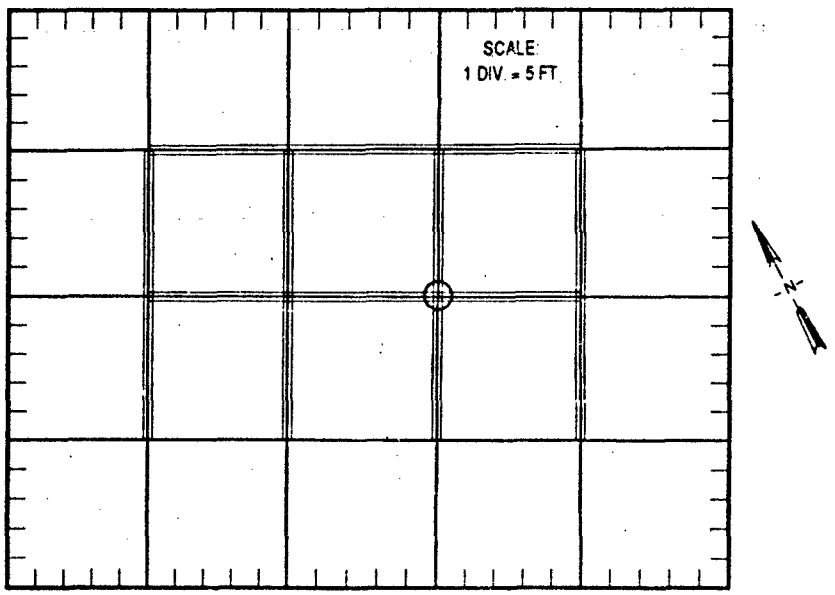
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 16 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: MOBAY BAYSILONE 960



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[ ]	[X]	[ ]	[X]
FEW	[X]	<11%	[ ]	<11%	[ ]	<11%	[ ]	<11%
FREQUENT	[ ]	11-50%	[ ]	11-50%	[ ]	11-50%	[ ]	11-50%
EXTENSIVE	[ ]	>50%	[ ]	>50%	[ ]	>50%	[ ]	>50%
COMPLETE	[ ]	100%	[ ]	100%	[ ]	100%	[ ]	100%

REMARKS: ○ - 2 INCH ADHESION FAILURE. RESIDUAL SEALANT ON JOINT FACE WHERE FAILURE OCCURRED; SEALANT DISCOLORATION

═══ SEALED JOINTS IN SECTION

Figure 54. One-year field evaluation - area 1 section 16

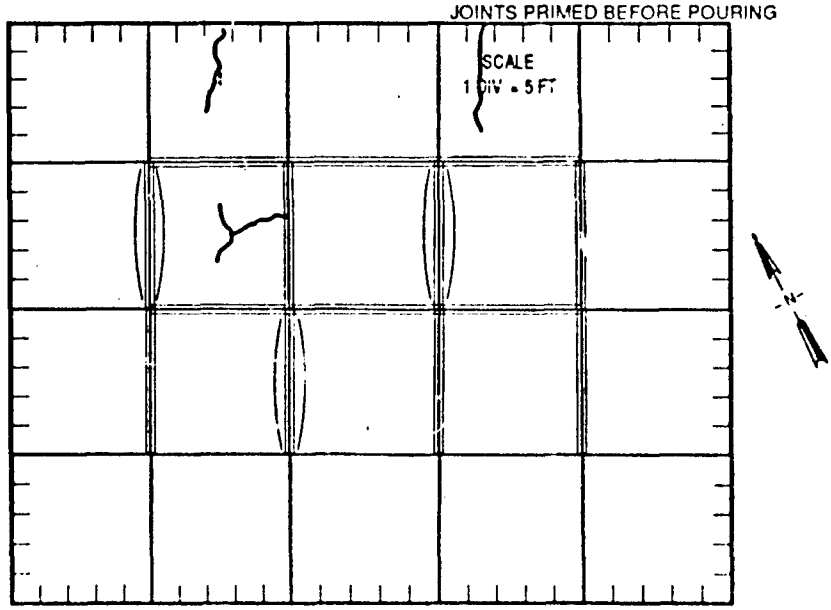
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 17 JOINT WIDTH SHAPE FACTOR 3/4" 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL KOCH PRODUCT 9005 WITH SELECTED JOINTS PRIMED BEFORE POURING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X <11%		FEW ☐ <11%		FEW ☐ <11%		FEW ☐ <11%	
FREQUENT	☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%	
EXTENSIVE	☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%	
COMPLETE	☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%	

REMARKS () JOINTS PRIMED WITH HOT APPLIED ASPHALT PRIMER, SEALANT REJECTED COIN 1/16-1/8 IN SEALANT SEPARATION FROM PAVEMENT SURFACE, 2-3 BUBBLES PER FOOT OF SEALANT, 1/4 IN BUBBLE DIAMETER, SWELLING IN EXCESS OF 1/4 IN SOME SURFACE CRACKING, NO DIFFERENCE IN PRIMED AND UNPRIMED JOINTS SEALANT TACKY BENEATH SURFACE

BUBBLE RATING - NO. OF BUBBLE - 1
BUBBLE SIZE - 2
SWELLING - 3

SEALED JOINTS IN SECTION

OVERALL RATING 6/3 = 2.0

Figure 55. One-year field evaluation - area 1 section 17

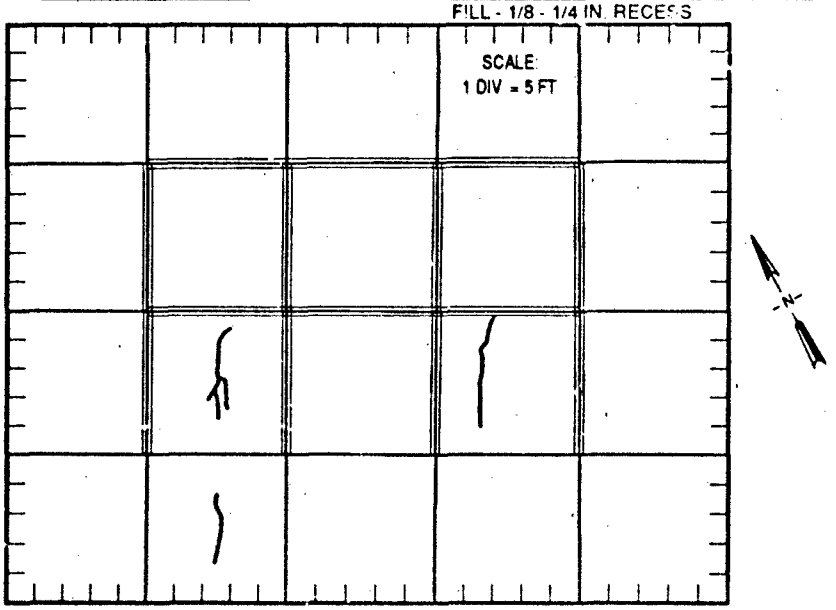
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 18 JOINT WIDTH: SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: CRAFCO ROADSAVER 222, STANDARD FILL - 1/8 - 1/4 IN. RECESS



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[ ]	[X]	[ ]	[X]
FEW	[X] <11%		FEW [ ] <11%		FEW [ ] <11%		FEW [ ] <11%	
FREQUENT	[ ] 11-50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%	
EXTENSIVE	[ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%	
COMPLETE	[ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%	

REMARKS: SEALANT RETAINED COIN, BUBBLES, 1-3 PER FOOT OF SEALANT, 1/4 IN. DIAMETER; 1/16-1/8 IN. SEALANT SEPARATION FROM CONCRETE FACE.

BUBBLE RATING - NO. OF BUBBLES - 2

BUBBLE SIZE - 2

SWELLING - 0

SEALED JOINTS IN SECTION

OVERALL RATING = 4/3 = 1.3

Figure 56. One-year field evaluation - area 1 section 18

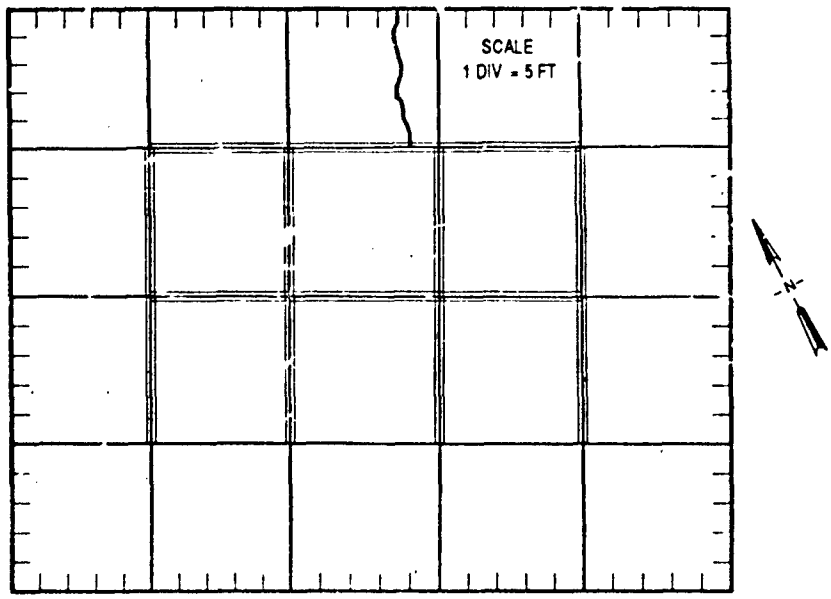
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 19 JOINT WIDTH SHAPE FACTOR 1/4" : 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL CRAFCO ROADSAVER 222, FLUSH FILL



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS SEALANT RETAINED COIN, 2-5 BUBBLES, 1/4 IN. DIAMETER PER FOOT OF SEALANT. 1/4 IN. SWELLING OF SEALANT; SURFACE CRACKING OF SEALANT

BUBBLE RATING - NO. OF BUBBLES - 2

BUBBLE SIVE - 2

SWELLING - 2

OVERALL RATING = 6/3 = 2

SEALED JOINTS IN SECTION

Figure 57. One-year field evaluation - area 1 section 19

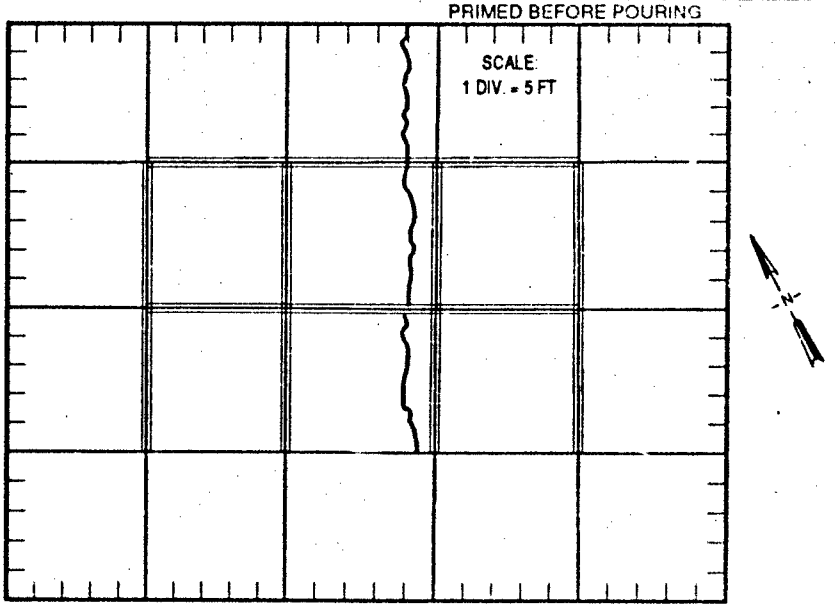
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 20 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: CRAFCO ROADSAVER 222, JOINTS PRIMED BEFORE POURING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X <11%		FEW ☐ <11%		FEW ☐ <11%		FEW ☐ <11%	
FREQUENT	☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%		FREQUENT ☐ 11-50%	
EXTENSIVE	☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%		EXTENSIVE ☐ >50%	
COMPLETE	☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%		COMPLETE ☐ 100%	

REMARKS: SEALANT RETAINED COIN; 3-4, 1/4 IN DIA BUBBLES PER FOOT OF SEALANT; 1/16 - 1/8 IN. SEPARATION OF SEALANT FROM CONCRETE; SURFACE CRACKING.

BUBBLE RATING - NO. OF BUBBLES - 1

BUBBLE SIZE - 2

SWELLING - 0

SEALED JOINTS IN SECTION

OVERALL RATING = 3/3 = 1

Figure 58. One-year field evaluation - area 1 section 20

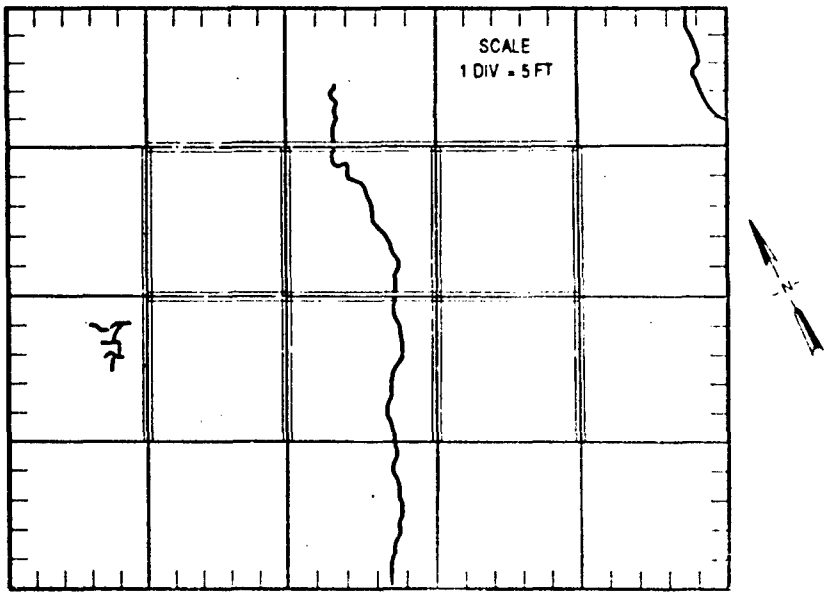
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 21 JOINT WIDTH SHAPE FACTOR 3/4" 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL CRAFCO IMPROVED NON JFR



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[X]	[ ]	[ ]	[X]
FEW	[X] <11%		[ ] <11%		[ ] <11%		[ ] <11%	
FREQUENT	[ ] 11-50%		[ ] 11-50%		[ ] 11-50%		[ ] 11-50%	
EXTENSIVE	[ ] >50%		[ ] >50%		[ ] >50%		[ ] >50%	
COMPLETE	[ ] 100%		[ ] 100%		[ ] 100%		[ ] 100%	

REMARKS SEALANT RETAINED COIN; 1-2 - 1/4 IN. DIAMETER BUBBLES PER FOOT, SEALANT SURFACE CRACKING; 1/16 - 1/8 IN. SEALANT SEPARATION FROM CONCRETE

BUBBLE RATING NO. OF BUBBLES 1

BUBBLE SIZE 2

SWELLING 0

SEALED JOINTS IN SECTION

OVERALL - 3/3 = 1

Figure 59. Ona-year field evaluation - area 1 section 21

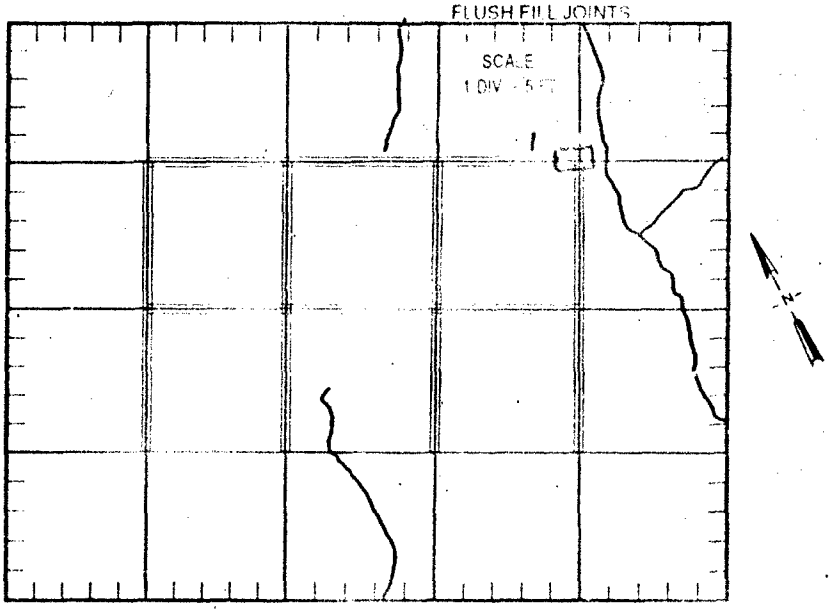
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 1 SECTION 22 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL CRAFCO IMPROVED NON JFR WITH FLUSH FILL JOINTS



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[ ]	[X]	[ ]	[X]
FEW	[X] <11%		[ ] <11%		[ ] <11%		[ ] <11%	
FREQUENT	[ ] 11-50%		[ ] 11-50%		[ ] 11-50%		[ ] 11-50%	
EXTENSIVE	[ ] >50%		[ ] >50%		[ ] >50%		[ ] >50%	
COMPLETE	[ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%	

REMARKS SEALANT RETAINED [illegible] 1/4 IN DIAMETER BUBBLES [illegible] SURFACE

CRACKING, 1/8 INCH SEPARATION [illegible] SEALANT FROM CONCRETE IN SOME AREAS

BUBBLE RATING - NO OF BUBBLES - 2

BUBBLE SIZE - 2

SWELLING - 0

SEALED JOINTS IN SECTION

OVERALL RATING = 4/3 = 1.3

Figure 60. One-year field evaluation - area 1 section 22

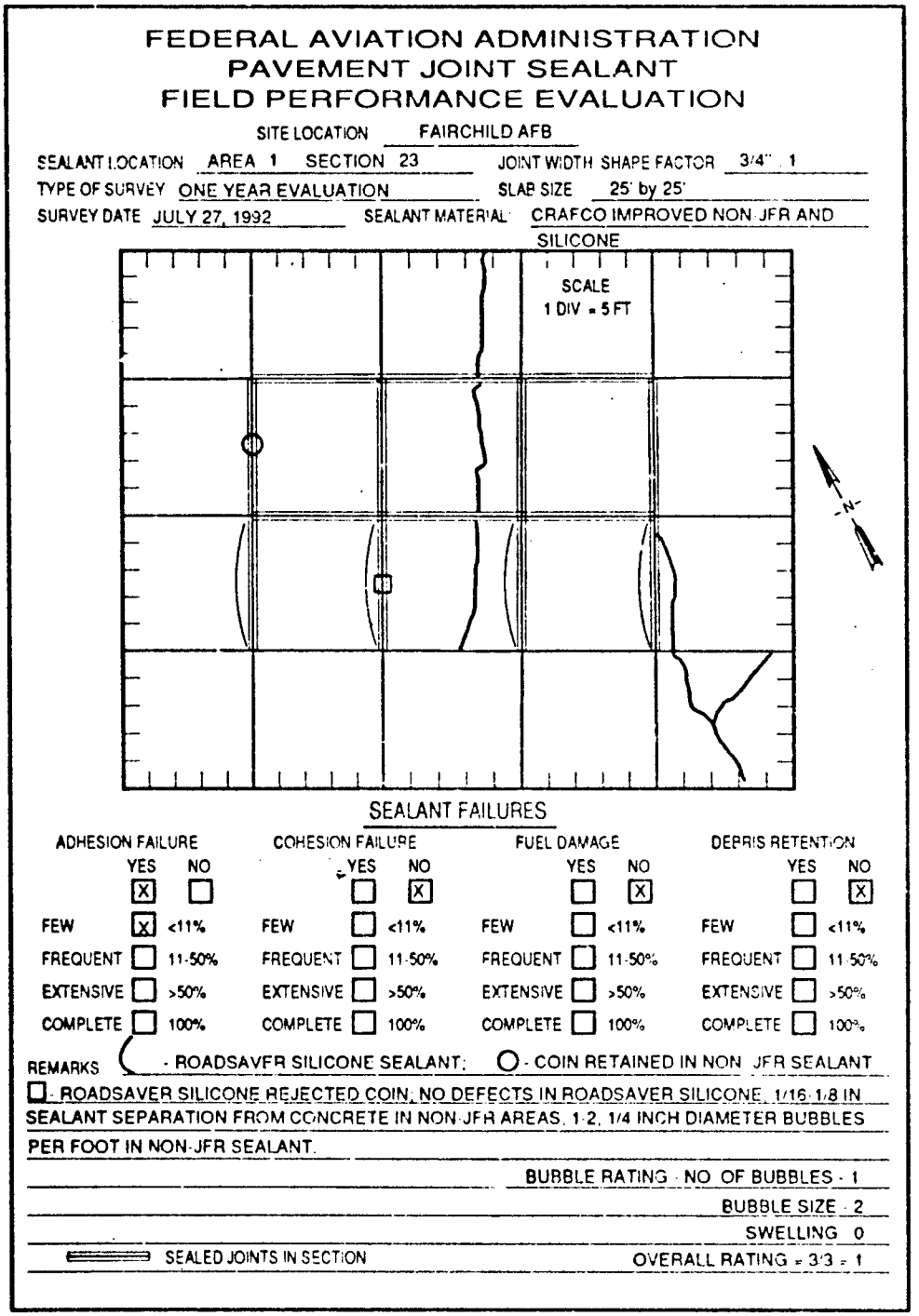


Figure 61. One-year field evaluation - area 1 section 23

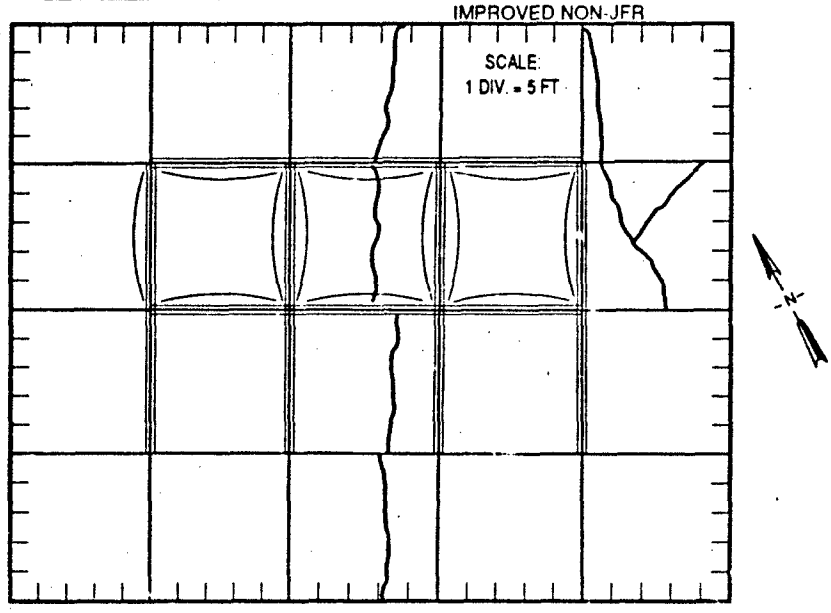
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 1 SECTION 24 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: CRAFCO ROADSAVER SILICONE AND IMPROVED NON-JFR



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS ROADSAVER SILICONE SEALANT REJECTED COIN; IMPROVED NON-JFR SEALANT RETAINED COIN, 1-4; 1/8 IN. DIAMETER BUBBLES PER FOOT IN NON-JFR SEALANT.

BUBBLE RATING - NO. OF BUBBLES - 1

SIZE OF BUBBLES - 1

SWELLING - 0

SEALED JOINTS IN SECTION

OVERALL RATING 2/3 = 0.67

Figure 62. One-year field evaluation - area 1 section 24

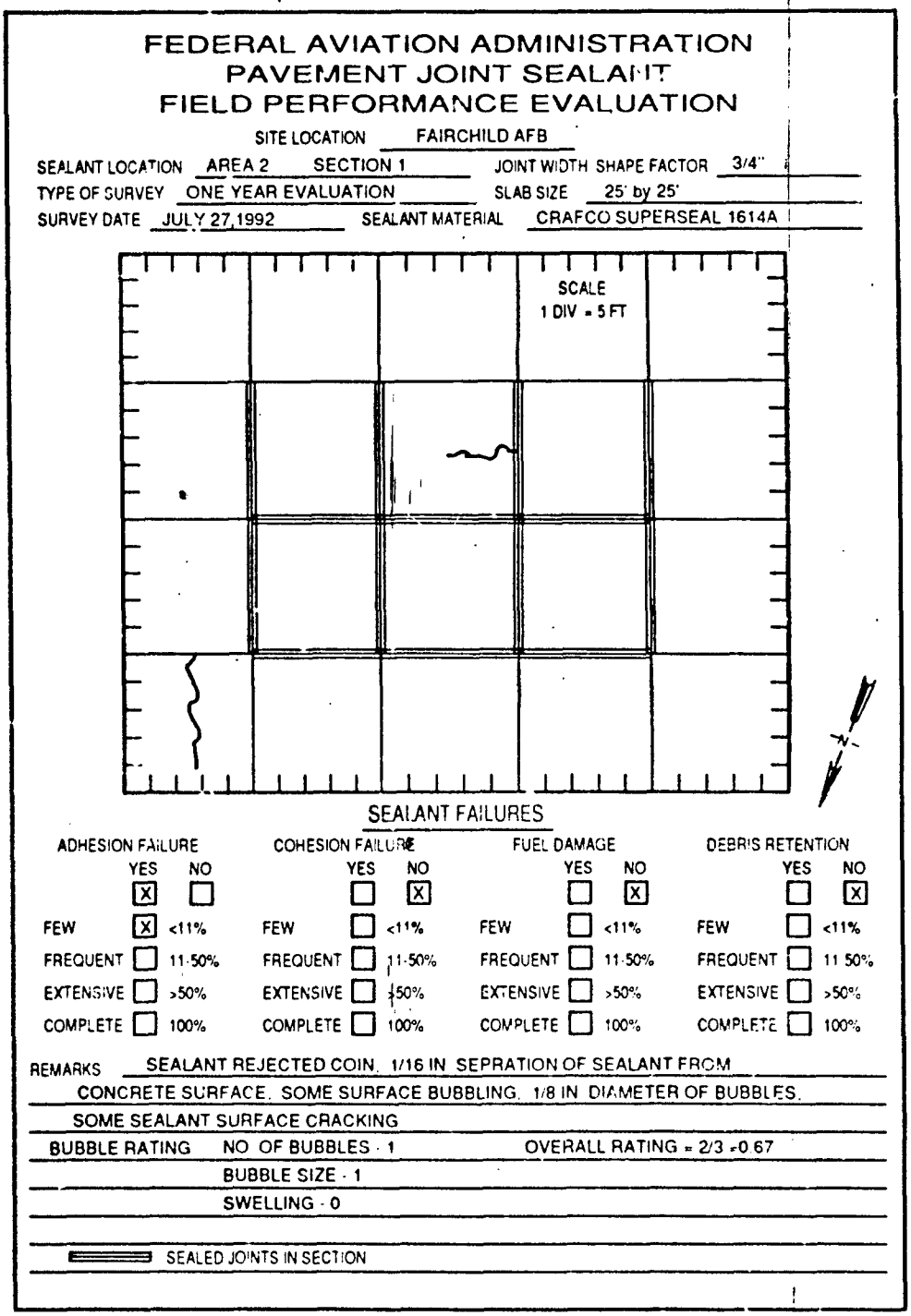


Figure 63. One-year field evaluation - area 2 section 1

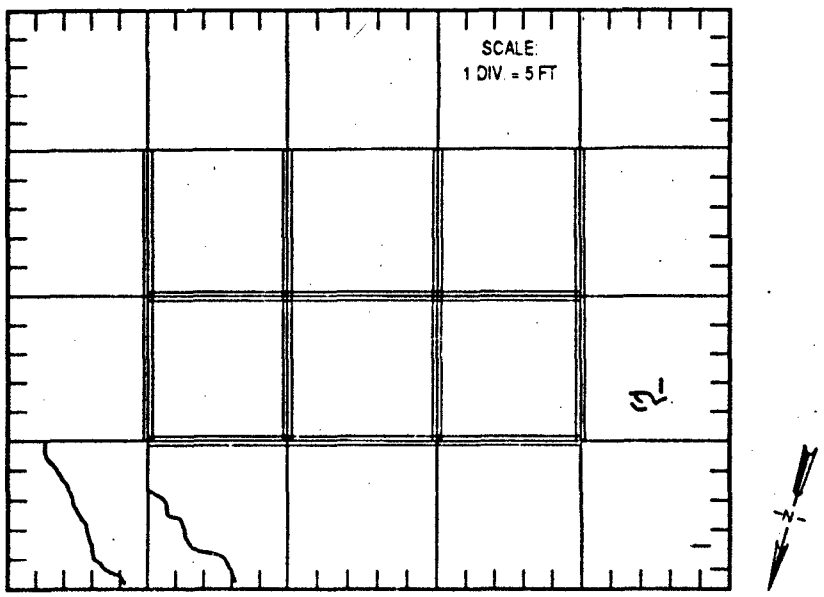
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 2 SECTION 2 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27,1992 SEALANT MATERIAL: CRAFCO IMPROVED JFR



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	☐	☒	☐	☒	☐	☒	☐	☒
FEW	☐ <11%		☐ <11%		☐ <11%		☐ <11%	
FREQUENT	☐ 11-50%		☐ 11-50%		☐ 11-50%		☐ 11-50%	
EXTENSIVE	☐ >50%		☐ >50%		☐ >50%		☐ >50%	
COMPLETE	☐ 100%		☐ 100%		☐ 100%		☐ 100%	

REMARKS: SEALANT REJECTED COIN, SEALANT DISCOLORED, LESS THAN ONE BUBBLE PER FOOT ON ISOLATED JOINTS, SOME SEALANT SURFACE CRACKING

BUBBLE RATING: NO. OF BUBBLES - 1 OVERALL RATING = 2/3 =0.67

BUBBLE SIZE - 1

SWELLING - 0

SEALED JOINTS IN SECTION

Figure 64. One-year field evaluation - area 2 section 2

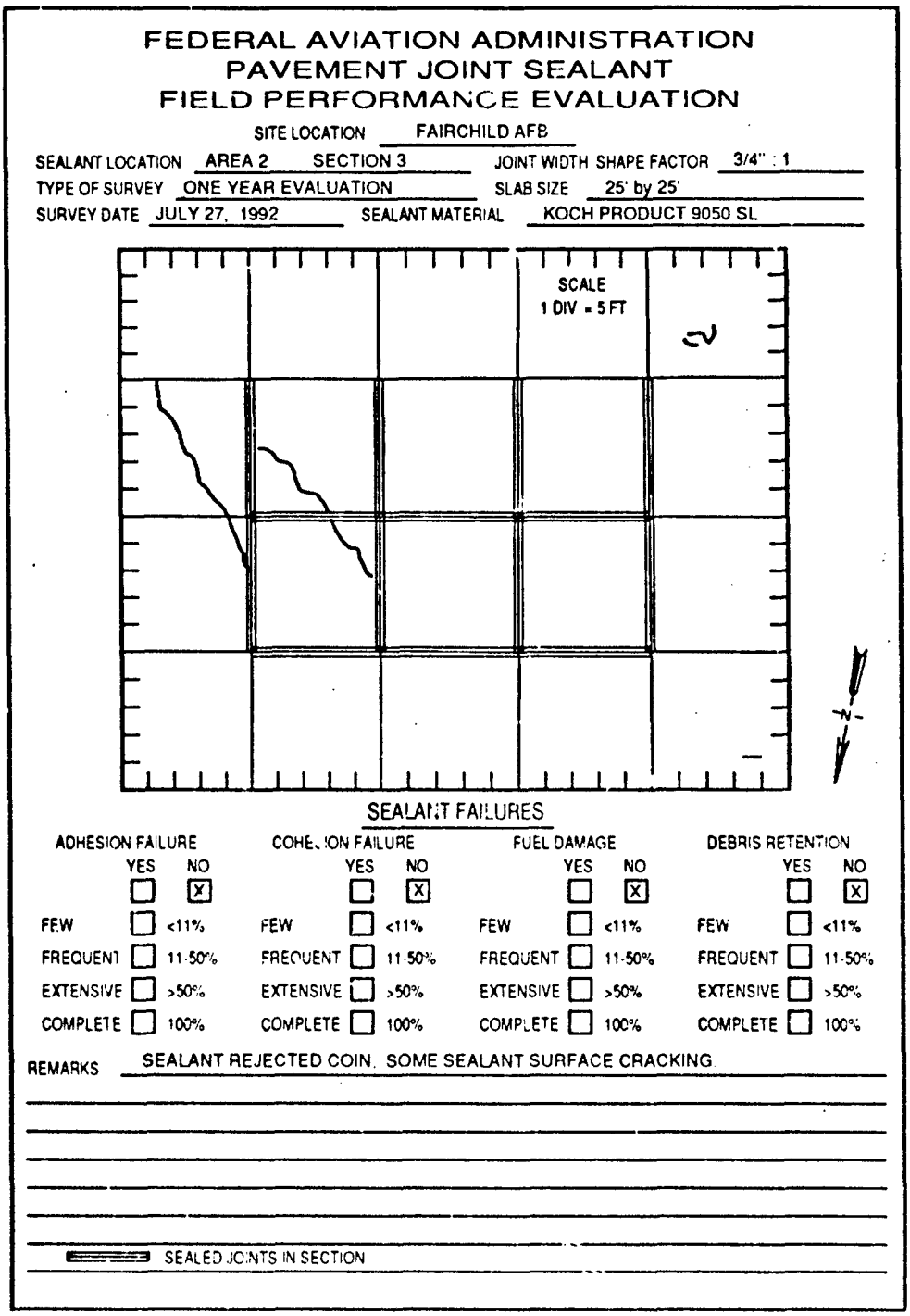


Figure 65. One-year field evaluation - area 2 section 3

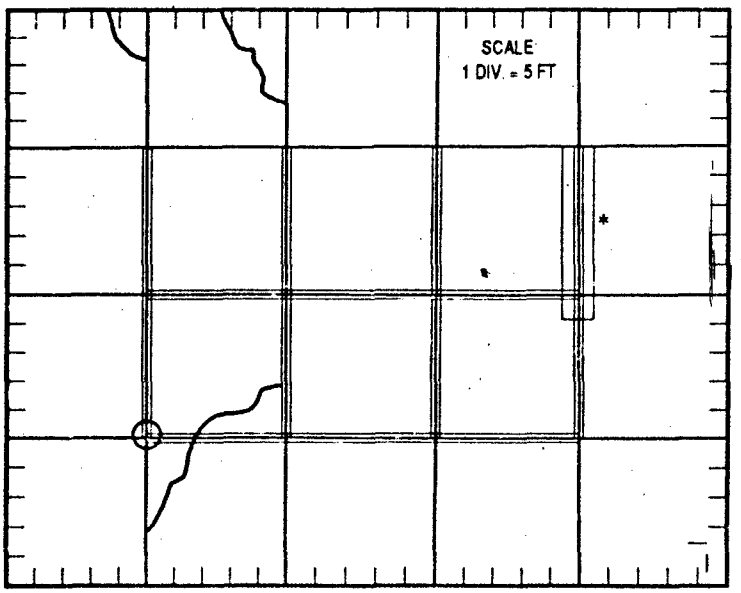
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 2 SECTION 4 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: KOCH PRODUCT 9020



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[ ]	[X]	[ ]	[X]
FEW	[X]	<11%	[ ]	<11%	[ ]	<11%	[ ]	<11%
FREQUENT	[ ]	11-50%	[ ]	11-50%	[ ]	11-50%	[ ]	11-50%
EXTENSIVE	[ ]	>50%	[ ]	>50%	[ ]	>50%	[ ]	>50%
COMPLETE	[ ]	100%	[ ]	100%	[ ]	100%	[ ]	100%

REMARKS: O - 9 INCHES OF ADHESION FAILURE CAUSED BY RESIDUAL SEALANT IN JOINT; SOME SEALANT SURFACE CRACKING

* THIS AREA SEALED WITH CRAFCO SUPERSEAL 1614A SINCE NOT ENOUGH PRODUCT 9020 AVAILABLE FOR SEALING

SEALED JOINTS IN SECTION

Figure 66. One-year field evaluation - area 2 section 4

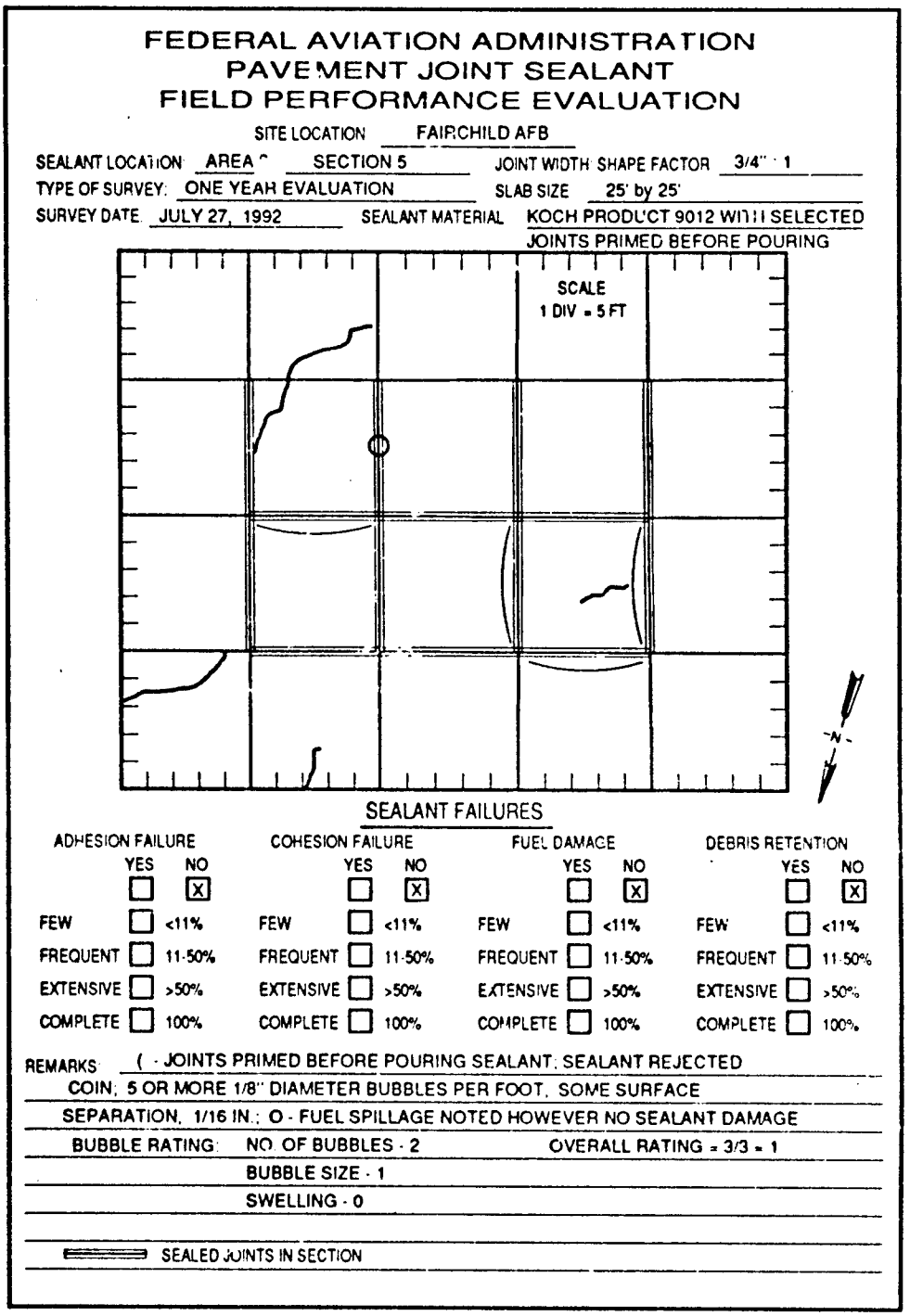


Figure 67. One-year field evaluation - area 2 section 5

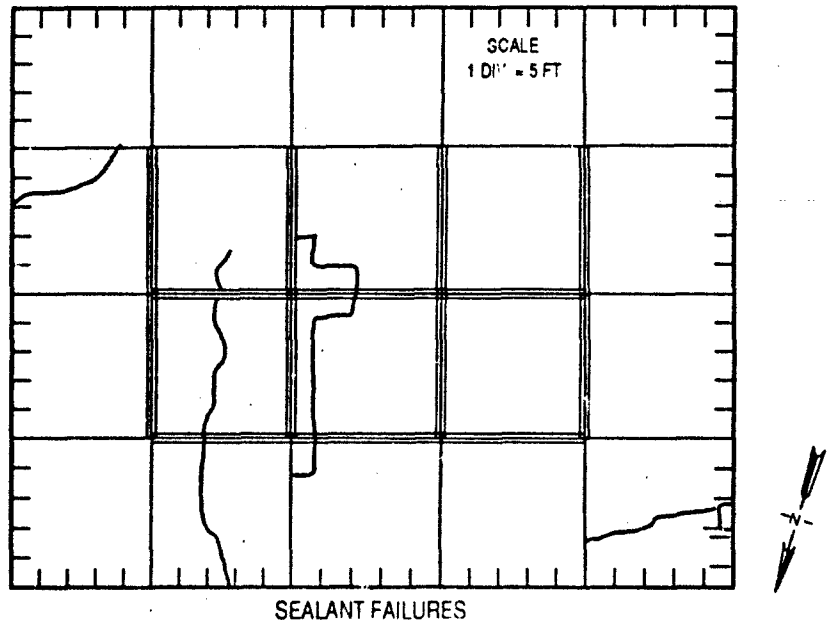
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 2 SECTION 6 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25' (EXCEPT AS SHOWN)

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: CRAFCO SUPERSEAL 1614A



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X	<11%		<11%		<11%		<11%
FREQUENT		11-50%		11-50%		11-50%		11-50%
EXTENSIVE		>50%		>50%		>50%		>50%
COMPLETE		100%		100%		100%		100%

REMARKS: SEALANT REJECTED COIN; SEALANT SURFACE CRACKING; SURFACE BUBBLES, 1 PER FOOT, 1/8 IN. DIAMETER; 1/16 IN. ISOLATED SEALANT SEPARATION FROM CONCRETE.

BUBBLE RATING: NO. OF BUBBLES - 1 OVERALL RATING = 2/3 = 0.67

BUBBLE SIZE - 1

SWELLING - 0

SEALED JOINTS IN SECTION

Figure 68. One-year field evaluation - area 2 section 6

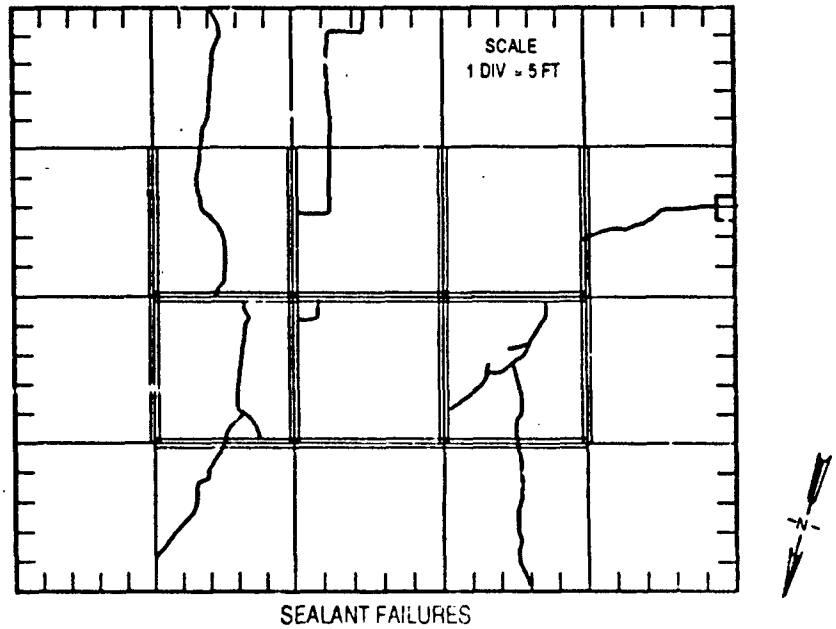
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 2 SECTION 7 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL CRAFCO IMPROVED JFR



SEALANT FAILURES

ADHESION FAILURE	YES	NO	COHESION FAILURE	YES	NO	FUEL DAMAGE	YES	NO	DEBRIS RETENTION	YES	NO
	☐	☒		☐	☒		☐	☒		☐	☒
FEW	☐	<11%	FEW	☐	<11%	FEW	☐	<11%	FEW	☐	<11%
FREQUENT	☐	11-50%	FREQUENT	☐	11-50%	FREQUENT	☐	11-50%	FREQUENT	☐	11-50%
EXTENSIVE	☐	>50%	EXTENSIVE	☐	>50%	EXTENSIVE	☐	>50%	EXTENSIVE	☐	>50%
COMPLETE	☐	100%	COMPLETE	☐	100%	COMPLETE	☐	100%	COMPLETE	☐	100%

REMARKS SEALANT REJECTED COIN. DISCOLORATION IN SEALANT

SEALED JOINTS IN SECTION

Figure 69. One-year field evaluation - area 2 section 7

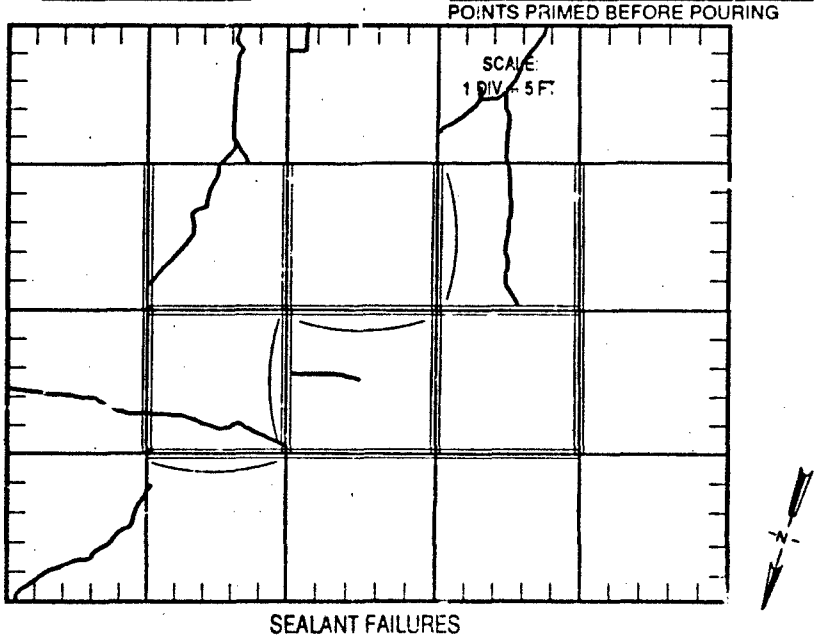
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 2 SECTION 8 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27, 1992 SEALANT MATERIAL: KOCH PRODUCT 9012 WITH SELECTED POINTS PRIMED BEFORE POURING



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
FEW	[X] <11%		FEW [ ] <11%		FEW [ ] <11%		FEW [ ] <11%	
FREQUENT	[ ] 11-50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%	
EXTENSIVE	[ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%	
COMPLETE	[ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%	

REMARKS: (- JOINTS PRIMED BEFORE POURING; SEALANT REJECTED COIN; SEALANT SEPARATION 1/16-1/8 IN.; 1/8 IN. DIAMETER SURFACE BUBBLING; SEALANT SURFACE CRACKING.

BUBBLE RATING: NO. OF BUBBLES - 1 OVERALL RATING = 2/3 =0.67

BUBBLE SIZE - 1

SWELLING - 0

SEALED JOINTS IN SECTION

Figure 70. One-year field evaluation - area 2 section 8

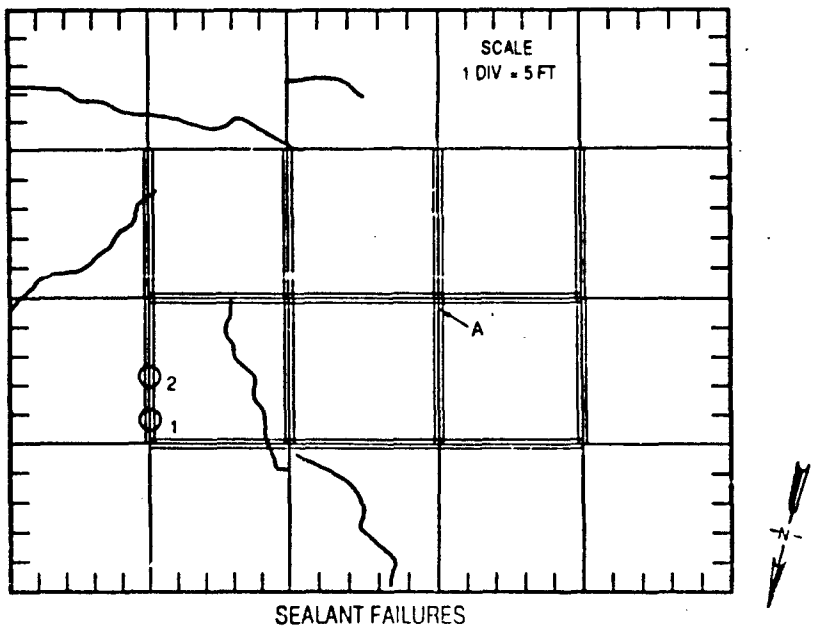
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION FAIRCHILD AFB

SEALANT LOCATION AREA 2 SECTION 9 JOINT WIDTH SHAPE FACTOR 3/4" : 1

TYPE OF SURVEY ONE YEAR EVALUATION SLAB SIZE 25' by 25'

SURVEY DATE JULY 27, 1992 SEALANT MATERIAL KOCH PRODUCT 9050 SL



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	X			X		X		X
FEW	X	<11%		<11%		<11%		<11%
FREQUENT		11-50%		11-50%		11-50%		11-50%
EXTENSIVE		>50%		>50%		>50%		>50%
COMPLETE		100%		100%		100%		100%

REMARKS SEALANT REJECTED COIN, SEALANT SURFACE CRACKING, 1 - ADHESION FAILURES, 6 INCHES LONG, 2 - ADHESION FAILURES 2.5 FT LONG, A - BACKER ROD OUT OF JOINT, ADHESION FAILURES CAUSED BY OLD SEALANT MATERIAL LEFT ON JOINT FACE

SEALED JOINTS IN SECTION

Figure 71. One-year field evaluation - area 2 section 9

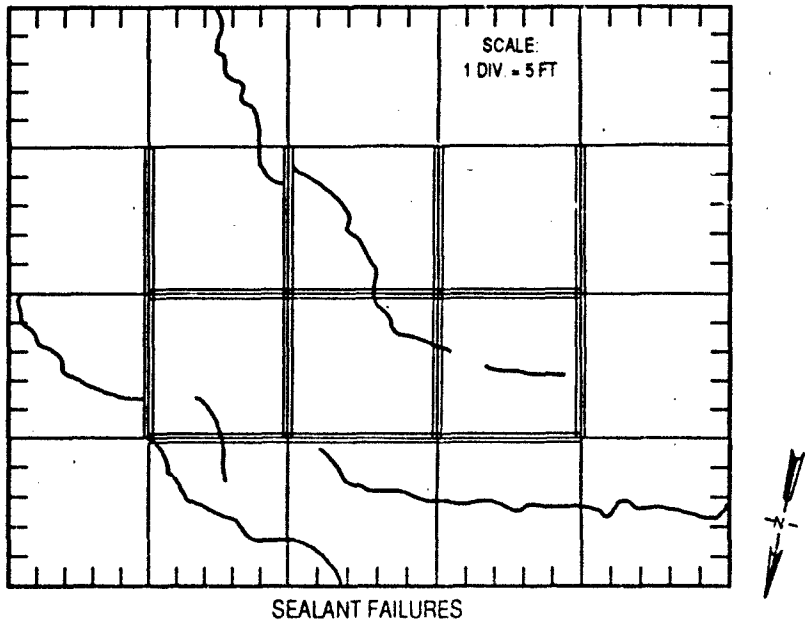
FEDERAL AVIATION ADMINISTRATION
PAVEMENT JOINT SEALANT
FIELD PERFORMANCE EVALUATION

SITE LOCATION: FAIRCHILD AFB

SEALANT LOCATION: AREA 2 SECTION 10 JOINT WIDTH: SHAPE FACTOR: 3/4" : 1

TYPE OF SURVEY: ONE YEAR EVALUATION SLAB SIZE: 25' by 25'

SURVEY DATE: JULY 27,1992 SEALANT MATERIAL: KOCH PRODUCT 9020



SEALANT FAILURES

	ADHESION FAILURE		COHESION FAILURE		FUEL DAMAGE		DEBRIS RETENTION	
	YES	NO	YES	NO	YES	NO	YES	NO
	[X]	[ ]	[ ]	[X]	[ ]	[X]	[ ]	[X]
FEW	[X] <11%		FEW [ ] <11%		FEW [ ] <11%		FEW [ ] <11%	
FREQUENT	[ ] 11-50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%		FREQUENT [ ] 11-50%	
EXTENSIVE	[ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%		EXTENSIVE [ ] >50%	
COMPLETE	[ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%		COMPLETE [ ] 100%	

REMARKS: SEALANT REJECTED COIN ; AREAS THROUGHOUT JOINTS WITH ADHESION FAILURE CAUSED BY RESIDUAL SEALANT LEFT ON JOINT FACES

SEALED JOINTS IN SECTION

Figure 72. One-year field evaluation - area 2 section 10

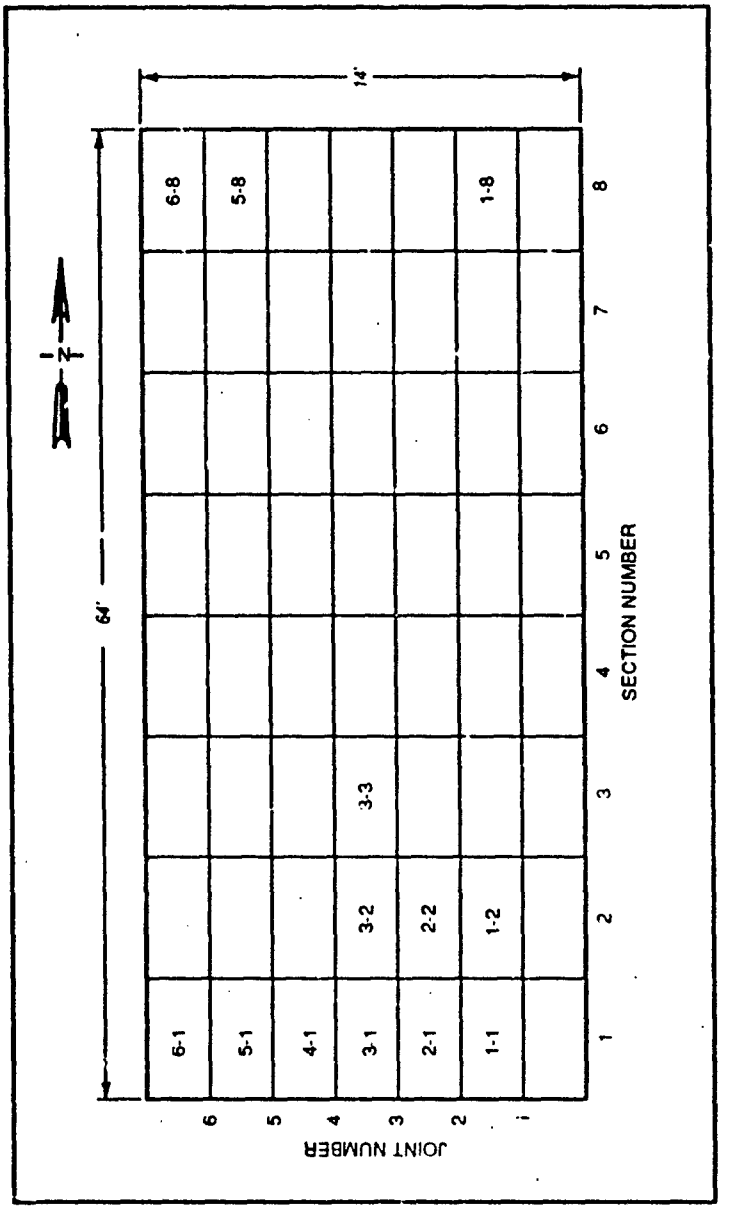


Figure 73. Concrete test slab plan

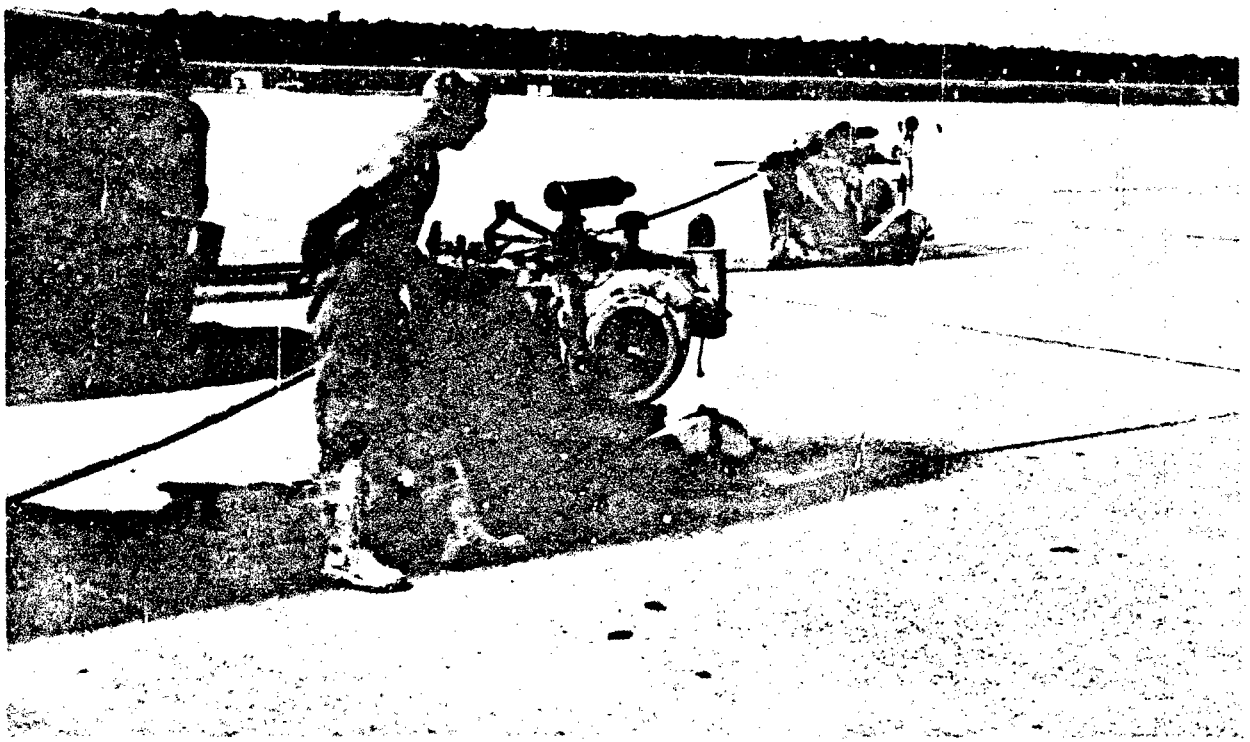


Photo 1. Water cooled concrete saw

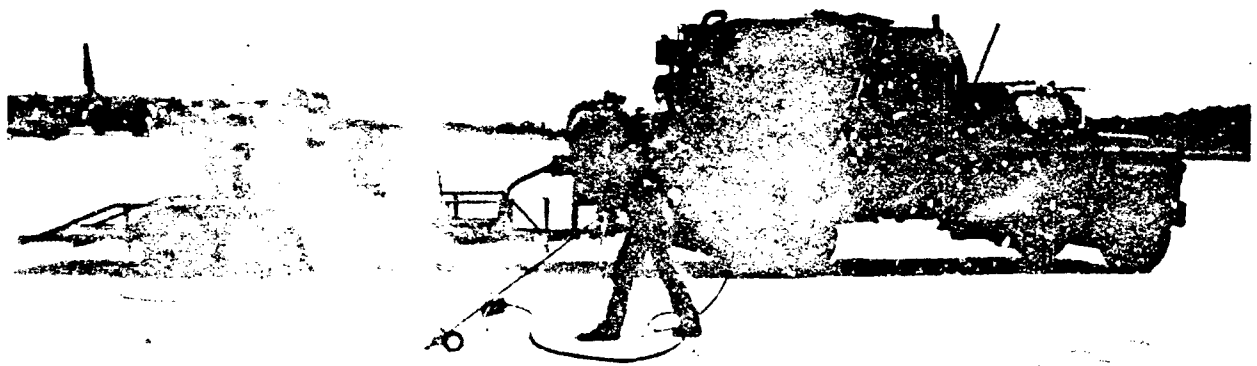


Photo 2. High pressure flushing of pavement joints

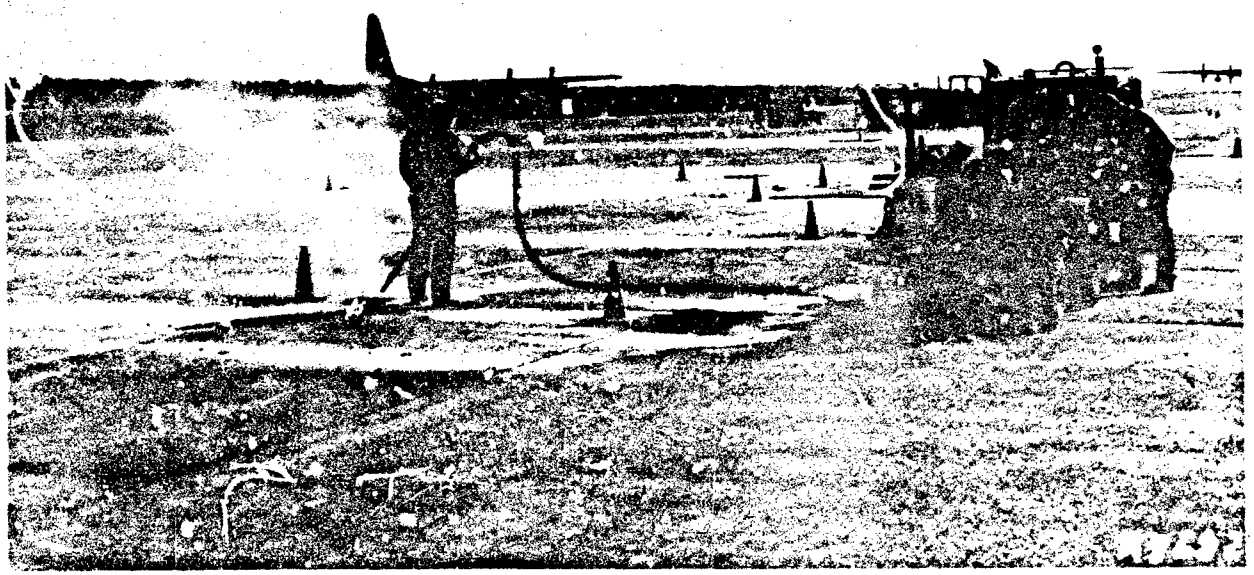


Photo 3. Sand blasting pavement joints

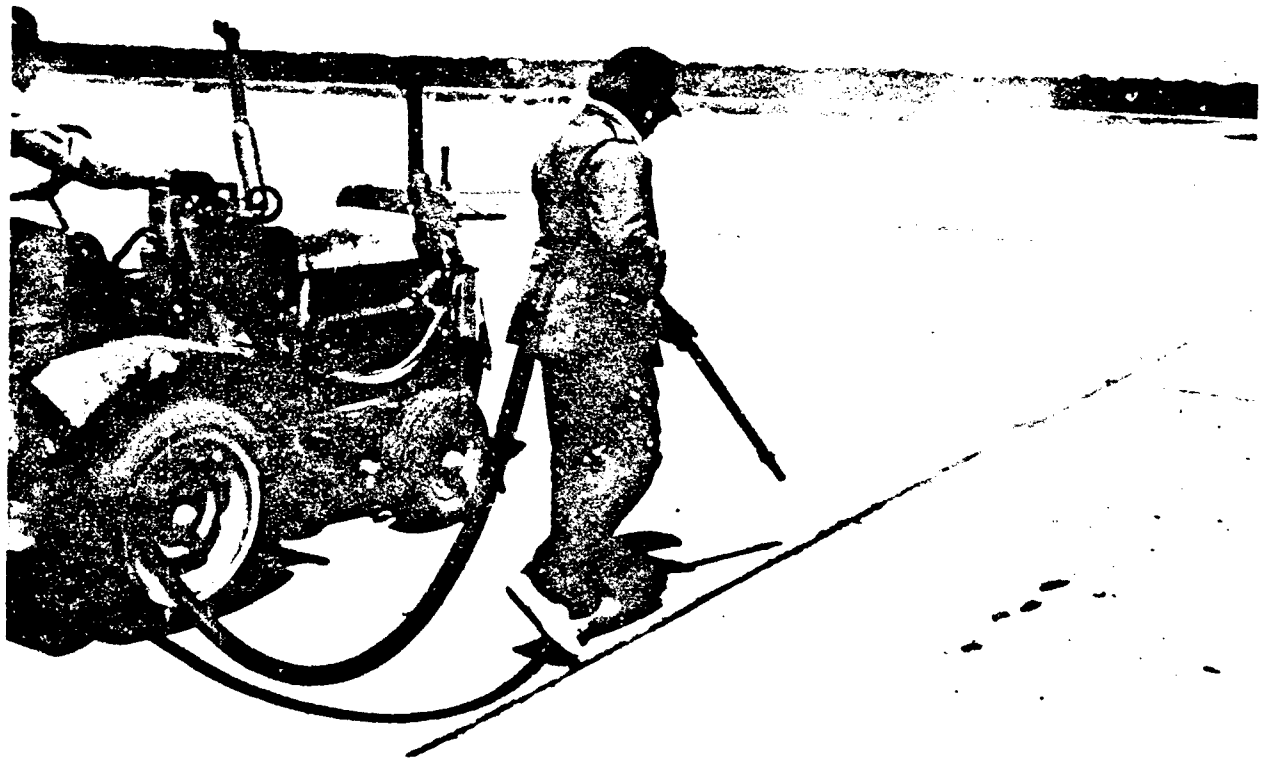


Photo 4. Cleaning of pavement joints with compressed air after sand blasting

Appendix A
Proposed Specification for Low Modulus, Hot-Applied, Non-Jet-Fuel-Resistant Pavement Joint Sealants for Rigid and Flexible Pavements[1]

1. SCOPE: This specification covers low modulus, hot-applied, non-fuel-resistant pavement joint sealant materials for use in sealing joints and cracks in rigid and flexible pavements that are exposed to cold ambient temperatures.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issues in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Federal Specification

PPP-P-704 - Pails, Metal: (Shipping, Steel, 1 through 12 Gallons)

Federal Standards

FED-STD-123 - Marking for Shipment (Civil Agencies)
FED-STD-313 - Material Safety Data Sheets Preparation and the Submission of

Military Standards

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes

[1] This proposed specification has not been finalized and changes may occur before it is published as a material specification. Therefore, it's use may not be applicable for project specifications.

MIL-STD-129 - Marking for Shipment and Storage
MIL-STD-147 - Palletized Unit Loads

Federal Regulations

29 CFR 1900-1999 - Occupational Safety and Health Administration (OSHA), Department of Labor

2.2 *Other Publications.* The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bid or request for proposal shall apply.

American Society for Testing and Materials (ASTM)

D 5 - Penetration of Bituminous Materials, Test Method for
D 140 - Sampling Bituminous Materials, Method of
D 217 - Cone Penetration of Lubrication Grease, Test Method for
D 1985 - Preparing Concrete Blocks for Testing Sealants for Joints and Cracks, Standard Practice for
D 5167 - Melting of Hot-Applied Joint and Crack Sealant and Filler Material for Evaluation, Standard Practice for

Technical Association of the Pulp and Paper Industry

T431 om - Ink Absorbency of Blotting Paper

2.3 *Order of Precedence.* In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall have precedence.

3. REQUIREMENTS

3.1 *Description.*

3.1.1 *Material.* The sealant shall be a fully polymerized and cured thermoplastic material, furnished as a solid. It shall be composed of a mixture of asphalt and rubber, with additives. The manufacturer's specified application of pouring temperature shall not exceed 232 deg (°C) (450 deg °F)), and shall be at least 11°C (20°F) lower than the safe heating temperature. The sealant shall meet the requirements of this specification when poured after held at the application temperature for no more than 10 min, and shall retain all of its properties with up to 3 hr of continuous heat.

3.1.2 *Performance.* The sealant shall form a resilient and adhesive compound, which effectively seals joints and cracks in pavements against the infiltration of moisture throughout repeated cycles of expansion and contraction. The sealant shall not flow from the joint or be picked up by pneumatic tires at ambient temperatures of 52°C (125°F) or below. The sealant shall have a uniform application or pouring consistency suitable for filling the joint or crack without the inclusion of blisters, bubbles, or discontinuities.

3.2 *Safe Heating Temperature.* The safe heating temperature is the highest temperature permitted by the manufacturer (see 5.3.3) and is a temperature to which the sealant can be heated for a duration of at least 3 hr, and still conform to all of the requirements specified herein.

3.3 *Penetration.* Penetration shall not exceed 15.0 millimeters (mm) (150 test units) (0.591 in.) or be less than 9.0 mm (90 test units) (0.354 in.) when the sealant is tested as specified in 4.4.3.

3.4 *Flow.* Flow shall not exceed 3.0 mm (0.118 in.), for either specimen when tested as specified in 4.4.4.

3.5 *Resilience.* Recovery shall be a minimum of 50 percent and shall not exceed 80 percent when the sealant is tested as specified in 4.4.5. The initial indentation shall not exceed 3.5 mm (0.138 in.) or be less than 1.0 mm (0.039 in.) when tested as specified in 4.4.5.

3.6 *Bond to Concrete.* No specimen shall develop any surface crack, separation, or other opening in the sealant, or between the sealant and the concrete blocks when the sealant is tested as specified in 4.4.6.

3.7 *Static Adhesion.* When the sealant is tested as specified in 4.4.7, none of the 3 specimens shall exhibit any crack, separation, or other opening in the sealant, or between the sealant and the concrete blocks exceeding 6.35 mm (0.25 in.) in depth. Additionally, none of the 3 specimens shall exhibit a total area of bare concrete exposed on the face of any single concrete block exceeding 160 mm^2 (0.25 $in.^2$).

3.8 *Compatibility with Asphalt.* There shall be no failure in adhesion, formation of an oily exudate at the interface between the sealant and the asphaltic concrete, or softening or other deleterious effect on the asphaltic concrete, when tested as specified in 4.4.7.

3.9 *Storage Stability.* When specified (see 6.2), the user agency will retain samples for verification of these requirements: The sealant, when stored for 2 years from date of delivery, at temperatures form -18°C to 46°C (0°F to 115°F), and tested in accordance with this specification, shall meet all of the requirements herein.

3.10 *Toxicity.* The material shall have no adverse effect on the health of personnel when used for its intended purpose in the manner recommended by the manufacturer. Questions pertinent to this effect shall be referred by the acquiring activity to the appropriate medical service who will act as advisor to the acquiring activity. The manufacturer's instructions shall provide personnel protection to meet OSHA requirements, including 29 CFR 1910.1000, 1910.1002, and 1910.1017, as applicable (see 4.5).

3.11 *Material Safety Data Sheets (MSDS).* MSDSs shall be prepared in accordance with FED-STD-313 and submitted as directed (see 6.2, 6.3, and 6.5).

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3.11 *Material Safety Data Sheets (MSDS).* MSDSs shall be prepared in accordance with FED-STD-313 and submitted as directed (see 6.2, 6.3, and 6.5).

4. QUALITY ASSURANCE PROVISIONS

4.1 *Responsibility for Inspection.* Unless otherwise specified, the contractor is responsible for the performance of all inspection requirements and may use his own or any other facilities suitable for the performance of the inspection requirements that are approved by the user agency. The user agency reserves the right to perform any inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 *Materials Inspection.* The contractor is responsible for insuring that supplies and materials are inspected for compliance with all the requirements specified herein and in applicable referenced documents.

4.2 *Classification of Inspection.* The inspection requirements specified herein are classified as follows:

a. Quality conformance inspection (see 4.2.1).

b. Inspection of preparation for delivery (see 4.6).

4.2.1 *Quality Conformance Inspection.* The quality conformance inspection shall be as specified in 4.4. Sampling shall be in accordance with 4.3.

4.3 *Sampling.* Unless otherwise specified (see 6.2), samples for testing shall be taken at the point of manufacturer in accordance with ASTM D 140. It shall be the responsibility of the contractor to determine that the samples taken are representative of the batches for shipment. The representative composite sample of the sealant shall consist of not less than 7 kg (15 lb) from each batch. A lot consisting of a single batch, if taken from filled containers, shall be sampled from 3 containers, selected at random, to make up the composite sample. Sample identification shall include the name of the testing agency, the contract or purchase order number, and special marking as specified in 5.3.3. Each container from which sample material has been taken shall be resealed and marked for identification.

4.4 *Testing.* Testing shall be conducted at a user-agency approved facility (see 6.2). Samples taken as specified in 4.3 shall be tested as specified in 4.4.1 through 4.4.7. Individual test values, and results of failure analyses of individual shall be recorded. Failure of the sealant to pass any test shall be cause for rejection of the lot, except as noted for bond specimen casting defects in 4.4.6.3, and as noted for a marginal test result. The exceptions for marginal test results are as follows: Where test results of only one of the

4.4.1 *Standard Conditions.* Laboratory atmospheric conditions, hereinafter referred to as standard conditions, shall be a temperature of 23±2°C (73±4°F) and 50±5 percent relative humidity. Specimens shall be stored and tested at standard laboratory conditions unless otherwise specified.

4.4.2 *Specimen Preparation.*

4.4.2.1 *Equipment.* The unit for melting the laboratory samples shall be as specified in ASTM D 5167.

4.4.2.2 *Melting.* The portion of the sample selected for testing shall provide approximately 1.6 cubic decimeter (1.7 quarts) of melted material. The portion of material selected shall be obtained from the original sample and melted as specified in ASTM D 5167. The sample shall be heated at the safe heating temperature until 3 hr have elapsed since the first segment was added to the melters.

4.4.2.3 *Pouring.* Pour all test specimens as specified in 4.4.3 through 4.4.7 within a period of 10 min. Discard the first 50 to 60 g of material discharged from each melting pot.

4.4.3 *Penetration.* Penetration testing shall be as specified in ASTM D 5 except as specified herein. Use a penetrometer as specified in ASTM D 217 with a cone conforming to the Optional Cone therein in place of the needle. Prepare specimen in 177 cubic centimeter (cc) (6 oz) container, and cast flush with the top edge. Make determinations at locations on 120° radii, and halfway between the center and outside of the specimen. Determine conformance to the requirements of 3.3.

4.4.4 *Flow.*

4.4.4.1 *Specimen Preparation.* Prepare duplicate specimens in molds with inside dimensions of 40 mm by 60 mm by 3.2 mm (1.56 in. by 2.34 in. by 0.125 in.), placed on a bright tin panel. Metal molds, coated with a release agent, such as a thin, cured film of heat-stable silicone (see 6.6.3), or equivalent, shall be used. Fill the molds with excess sealant and allow the specimens to cool at standard laboratory conditions for a minimum of 30 min. After the specimens have cooled, trim off the excess sealant flush with the face of the mold with a heated knife or spatula.

4.4.4.2 *Test.* Remove the molds and mark reference lines across the panels coincident with the transverse edge of the specimens. Mount the specimens with the long axis at an angle of 75±1° with the horizontal and the transverse axis horizontal, in a forced-draft oven maintained at 60±1°C (140±2°F). After 5 hr, remove the specimens and mark a reference line on each specimen coincident with the lowest point of sag or flow, and parallel to the reference line. Measure the indicated change in length of the specimen and report as flow. Determine conformance to the requirements of 3.4.

4.4.5 *Resilience.*

4.4.5.1 *Specimen Preparation.* Prepare duplicate specimens as specified in 4.4.3, except cure the specimens for 24 hr at standard laboratory conditions prior to testing. Oven-age one specimen in a forced-draft oven at 70±1°C (158±2°F) for 168±2 hr, cool at standard laboratory conditions for 1 hr, and then condition for 1 hr in a water bath maintained at 25±0.3°C (77±0.5°F) prior to testing. Condition the unaged specimen for 1 hr in a water bath maintained at 25±0.3°C (77±0.5°F) prior to testing.

4.4.5.2 *Procedure.* Use a penetrometer as specified in ASTM D 217, substituting the ball penetration tool illustrated in Figure 1 for the needle. Lightly dust the surface of the specimen with talc and immediately remove the excess by blowing. Place the ball in contact with the surface of the specimen and set the indicating dial to zero. Position a light so that initial contact of the ball with the specimen surface can be readily observed. Release the ball penetration tool and allow the ball to penetrate the specimen for 5 sec. Record this reading as penetration (P) in tenth-millimeter units. Without returning the dial pointer to zero, press the ball penetration tool down for an additional 100 units (i.e., to a dial reading of P+100) at a uniform rate within 10 sec. Re-engage the clutch to hold the ball in this position for 5 sec and during this time return the indicator dial to zero. Release the clutch, allow the specimen to recover for 20 sec, and record the final dial reading (F). Make determinations at 3 points equally spaced from each other and not less than 13 mm (0.5 in.) from the container rim. Calculate the recovery, a measure of resilience, as follows:

$$\text{Recovery, percent} = P + 100 - F$$

Report the averages of 3 determinations of recovery and initial penetration for each specimen. Determine conformance to the requirements of 3.5.

4.4.6 *Bond to Concrete.*

4.4.6.1 *Extension Machine.* The extension machine used in the bond testing shall be so designed that the specimen can be maintained at the test temperature while being extended at a uniform rate as specified. It shall consist essentially of one or more screws rotated by an electric motor through suitable gear reductions. Self-alinging plates or grips, one of each pair fixed and the other carried by the rotating screw or screws, shall be provided for holding the test specimen in position during the test.

4.4.6.2 *Concrete Block Preparation.* The concrete blocks used for bond testing shall be prepared as specified in ASTM D 1985. The blocks may be prepared by the testing agency or procured (see 6.6.3).

4.4.6.3 *Specimen Preparation.* Prepare 6 bond test specimens (12 blocks) as follows: Remove blocks from the storage water individually, scrub the 50 mm by 75 mm (2 in. by 3 in.) faces lightly with a stiff bristle brush, under running water, and resubmerge in fresh tap water until all blocks have been scrubbed. Remove all blocks from the water and lightly blot with an oil-free, soft, absorbent cloth or paper to remove all free surface water. Place the

blocks, 3 each, with the 50 mm by 75 mm faces down, centered and uniformly spaced 25 mm (1 in.) apart on sheets of blotting paper placed on a plane, solid, nonabsorbent surface. The sheets shall be approximately 100 mm by 240 mm (4 in. by 9.5 in), cut from material having a maximum absorption time of 28 sec as measured by TAPPI T431 (see 6.6.4). At the end of 1 hr, assemble pairs of concrete blocks to provide test specimens. Complete setup and pour specimens within 1 hr. Spacers and the base plate used for the test specimens shall have nonadherent, nonreactive surfaces (see 4.4.4.1). Place the spacer strips not less than 6.35 mm (0.25 in.) thick on a base plate to form an open space 12.7 mm (0.5 in.) wide and 50 mm by (2 in.) long. Place pairs of the concrete blocks on the spacers so that the 25 mm by 75 mm faces are on the spacers and the 50 mm by 75 mm faces which were against the blotter paper form the space to be filled by the sealant. Space the blocks 12.7±0.1 mm (0.500±0.005 in.) apart with 12.7±0.1 mm square by 75 mm long spacers. Corners may be slightly rounded, but discard spacers that have a diagonal dimension less than 16.51 mm (0.650 in.). Place these spacer strips at a distance from the ends of the blocks so that an opening 12.7±0.1 mm by 50 mm by 50 mm (0.5±0.005 in. by 2 in. by 2 in.) is formed. Place spacer strips that are a minimum of 12.7 mm thick on top of the blocks to provide for an overfill. Clamps or other suitable means may be used to hold the blocks and overfill spacers in position. Pour sealant prepared in accordance with 4.4.2 into the space between the blocks in sufficient quantity to bring it at least even with the top of the overfill spacers, and in a manner to exclude air pockets from being trapped in the sealant. After the specimens have cooled to standard conditions, remove the excess sealant protruding beyond the top and bottom of the concrete blocks by trimming with a hot knife or spatula. If the material shrinks on cooling below the top of the blocks, or if other casting defects are apparent, discard the specimens and prepare additional ones. Cool the specimens at least 2 hr, but no more than 24 hr, at standard laboratory conditions before subjecting them to test conditions.

4.4.6.4 *Nonimmersed Bond.* Condition 3 bond test specimens, with spacers maintaining the 12.7 mm dimensions, at the test temperature of -29±1°C (-20±2°F), with forced air circulation for 4 to 16 hr. Then extend the specimen 25.4 mm (1 in.) at a uniform rate of 3.18 mm (0.125 in.) per hr, while maintaining the specimens at the test temperature. Remove the specimens from the extension machine and reinsert the 12.7 mm spacers, and examine the spacers as described in 4.4.6.6. Then allow the specimens to return to the original dimensions at standard conditions, resting each specimen on one concrete block so that the weight of the top block recompresses the joint sealant. Three cycles of conditioning, extension, and recovery shall be completed within 5 days after the start of the first cycle, and shall constitute one complete test for the nonimmersed bond. When initiation of the second or third cycle is delayed, store the specimens at the test temperature.

4.4.6.5 *Water-Immersed Bond.* Insert thinner spacers between the concrete blocks of the remaining three bond specimens, so that an opening of not less than 6.35 mm by 12.7 mm by 50 mm (0.25 in. by 0.5 in. by 2 in.) will be produced and maintained between the spacers and the sealant. Using covered

containers deep enough to provide a minimum of 12.7 mm water cover, immerse the specimens for 96 hr in 500 cc (16.9 oz) of distilled or deionized water per specimen, and maintain at standard laboratory temperature. Place the specimens with the concrete blocks in a horizontal position. Three specimens may be placed in the same container, provided that the water-to-specimen ratio is maintained. At the end of the 96 hr immersion period, remove the test specimens from the water, remove the spacers, and remove the excess surface water from the specimens with a soft, dry, absorbent material. Subject the specimens to conditioning and extension test as specified in 4.4.6.4. One cycle of immersion and three cycles of conditioning, extension, and recovery shall constitute one complete test for water-immersed bond (see 4.4.6.6).

4.4.6.6. *Bond Test Results.* Remove the bond test specimens from the extension machine within 30 min after the completion of the extension of each of the first two test cycles and examine the specimens for obvious separations within the sealant and between the sealant and the concrete blocks without distorting or manually causing extension of the specimens. Immediately upon completion of the final cycle, insert both sets of spacers or otherwise maintain 50 percent extension during examination and dimensional measurements, examining the specimens thoroughly, while still frozen, for separations between the sealant and concrete blocks and within the sealant, including surface cracks. This shall be accomplished without distorting the specimens, but after recovery as specified in 4.4.6.4, the specimens may be extended uniformly up to 25.4 mm (1 in.) to permit further detailed examination. Determine conformance to the requirements of 3.6.

4.4.7 *Static Adhesion.*

4.4.7.1 *Specimen Preparation.* Prepare 3 bond test specimens as specified in 4.4.6.2 and 4.4.6.3 of this specification.

4.4.7.1 *Procedure.* Condition 3 bond test specimens, with spacers maintaining the 12.7 mm (0.5 in.) dimensions, at a test temperature of -29±1°C (-20±2°F), with forced air circulation, for not less than 4 hr. Then extend the specimens 12.7 mm (0.5 in.) at a uniform rate of 3.18 mm (0.125 in.) per hour while maintaining the specimens at the test temperature. Remove the test specimens from the extension machine and insert 25.4 mm (1 in.) spacers to maintain the 12.7 mm extension. Store the specimens at standard laboratory conditions for 24 hr and then examine them for the separations between the sealant and the concrete blocks or within the sealant. Determine conformance to the requirements of 3.7.

4.4.8 *Compatibility with Asphalt.*

4.4.8.1 *Specimen Preparation.* Prepare duplicate specimens of hot-mix asphaltic concrete, not less than 100 mm (4 in.) in diameter and 64 mm (2.5 in.) high using 85 - 100 penetration asphalt cement. Density and asphalt content shall be for asphaltic concrete pavement mix design and design method as specified (see 6.2 and 6.7). Specimens other than circular, but of

similar dimensions and properties may be used. Allow the specimens to cool to standard laboratory temperature, then cut a groove 100 mm (4 in.) long by 13±3.2 mm (0.5±0.125 in.) wide by 19±3.2 mm (0.75±0.125 in.) deep in the surface of the specimen by wet sawing with a power driven masonry saw. Remove all residue from the grooves by scrubbing with a stiff-bristle brush under running water. Allow the specimens to return to standard laboratory conditions and securely wrap with cloth-backed adhesive tape, or otherwise reinforce to prevent slumping during the test period. Caulk the ends of the grooves to prevent leaking of the sealant during testing. Pour sealant, prepared in accordance with 4.4.2, into the groove, overfilling slightly, but not allowing overflow onto the adjacent asphaltic concrete surface. Allow the specimen to cool to standard laboratory temperature, then trim any overfill flush, using a hot knife or spatula.

4.4.8.2 *Procedure*. Place the specimens in a forced-draft oven maintained at 60±3°C (140±5°F) for 168±2 hr. Inspect at least once each day for specimen damage. Immediately after removing the specimen from the oven and again after cooling to standard laboratory temperature, examine the specimens for incompatibility of the sealant with the asphaltic concrete. Determine conformance to the requirements of 3.8.

4.5 *Toxicological Data and Formulations*. The manufacturer shall provide a listing of the components in the sealant that when heated could produce hazardous vapors (see 5.3.3). Where precautions need to be taken relative to the inhaling of, or skin or eye contact with the material or vapors, these precautions shall be included in the manufacturer's instructions (see 3.9 and 5.3.3.1).

4.6 *Inspection of Preparation for Delivery*.

4.6.1 *Sampling*. Sampling for inspection of filled containers shall be in accordance with MIL-STD-105, inspection Level II. The unit of product shall be one unit prepared for shipment.

4.6.2 *Examination*. Each filled container selected shall be inspected for conformance to the requirements of Section 5. Inspection shall be based on an Acceptable Quality level of 2.5 percent defective.

5. PREPARATION FOR DELIVERY

5.1 *Packing*. Packing shall be Level A, B, or Commercial as specified (see 6.2).

5.1.1 *Level A*. The material shall be packed in a close-fitting, tapered 24-gage metal pail with gasket and lug cover. Pails shall have a wire handle securely attached to ears or clips which shall be attached to the body of the pails. The exterior surfaces of the pails shall be coated as specified in PPP-P-704. The unit pack quantity shall be one unit of issue quantity specified in the contract or purchase order.

5.1.2 *Level B.* The material shall be packed the same as for Level A except that the exterior surfaces of the pail shall be coated with a commercial coating.

5.1.3 *Commercial.* The material shall be packed to insure carrier acceptance and safe delivery to the destination in containers complying with the rules and regulations applicable to the mode of transportation.

5.2 *Palletization.*

5.2.1 *Level A.* Unless otherwise specified (see 6.2), material shall be palletized in accordance with MIL-STD-147.

5.2.2 *Level B and Commercial.* When specified (see 6.2), material shall be palletized in accordance with MIL-STD-147.

5.3 *Marking.*

5.3.1 *Civil Agencies.* Shipments to civil agencies shall be marked in accordance with MIL-STD-123.

5.3.2 *Military Agencies.* Shipments to military agencies shall be marked in accordance with MIL-STD-129.

5.3.3 *Special Marking.* In addition to the marking of 5.3.1 or 5.3.2, and any special marking of the contract or order, the following information shall be shown on each pail:

a. Name of sealant

b. Specification number

c. Manufacturer's name and material designation

d. Manufacturer's lot and batch number

e. Date of manufacturer (month and year)

f. List of hazardous components (see 4.5)

g. Quantity of sealant in pail (net weight)

h. Application or pouring temperature

i. Safe heating temperature

j. Instructions for use

5.3.3.1 *Instruction for Use.* The instructions for use (see 6.8) shall include, but not limited to the following: Ambient temperature and humidity ranges,

and moisture conditions of joints, for successful installation; essential requirements for preparation of joints, heating of the sealant, handling, placing, and disposal of hot materials; and any restrictions to be adhered to in order to reduce hazards to personnel or to the environment. If it is not feasible to include all the instructions on the container without sacrificing legibility, the most important information shall be shown on the container and the full instructions referenced and furnished separately.

6. NOTES

6.1 *Intended Use*. This sealant is intended for sealing joints and cracks in rigid or flexible pavements that are not exposed to spillage of jet fuels and lubricating oils. It is not intended to be resistant to the heat and blast of jet aircraft engines, except when aircraft are moving at moderate speeds.

6.2 *Ordering Data*. Purchasers shall select the preferred options permitted herein, and include the following in procurement documents:

a. Title, number and date of this specification

b. When stability samples are required, quantity to be retained and by what activity (see 3.8 and 6.4)

c. Addresses for submission of MSDS (see 3.10 and 6.5)

d. Sampling, if other than as specified (see 4.3)

e. Designation of Government approved test facility (see 4.4)

f. Density and asphalt content values for asphaltic concrete pavement mix design and design method required (see 4.4.7.1)

g. Level of packing required (see 5.1)

h. If palletization is not required for Level A (see 5.2.1)

i. When palletization is required for Level B or Commercial (see 5.2.2)

6.3 *Data Requirements*. When this specification is used in an acquisition which incorporates DD Form 1423, Contract Data Requirements List (CDRL) and invokes the provisions of paragraph 52.227-7031 of the Federal Acquisition Regulations (FAR), the data requirements will be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL (DD Form 1423) incorporated into the contract. When the provisions are not invoked, the data shall be delivered in accordance with the contract requirements (see 3.10).

6.4 *Stability Samples*. The date of delivery shall be marked on samples submitted for stability testing (see 3.8).

6.5 *MSDS Submission and Forwarding*. MSDS copies shall be forwarded to the designated Industrial Hygienist and the focal point of the activity that purchased the item, and the focal point of the using activity if different from purchasing activity. After review and acceptance of MSDS by designated recipients, approved copies will be forwarded to arrive at the destinations prior to material delivery (see 3.10).

6.6 *Availability of Testing Materials and Apparatus*. Known suppliers of specified testing materials and apparatus are as follows:

6.6.1 *Melting Unit*. A unit as specified in 4.4.2.1: Laboratory Melter Model BLM-100, Berry Corporation, P.O. Box 337, Nicholas, KY 40356.

6.6.2 *Release Agent*. An agent as specified in 4.4.4.1: Dow Corning 20 release coating, Dow Corning Corporation, Midland, MI 48640.

6.6.3 *Concrete Blocks*. Blocks as specified in 4.4.6.2: U.S. Army Corps of Engineers, Missouri River Division Laboratory, 420 South 18th Street, Omaha, NE 68102.

6.6.4 *Blotting Paper*. Paper as specified in 4.4.6.3: White Reliance Blotting Paper, Product Code 13-01-12, James River Paper Company, Incorporated, 145 James Way, Southhampton, PA 18966.

6.7 *Asphalt Compatibility Specimens*. The specimens of hot-mix asphalt concrete as specified in 4.4.7.1 may be prepared using the methods described in ASTM D 1074, D 1559, D 1561.

6.8 *Precautions*. The sealant material can be damaged by heating at too high a temperature, reheating, or by heating for too long a period of time. The temperature of the sealant in the melting equipment should never exceed the safe heating temperature set by the manufacturer. Any given quantity of material should never be heated at the application or pouring temperature for more than 3 hr and should never be reheated. Sealant material left in the equipment at the end of the working day should be removed and discarded. The sealant should be heated in a kettle or tank constructed as a double boiler, with the space between the inner and outer shells filled with heat transfer oil. Positive thermostatic control, mechanical agitation, and recirculating pumps should be provided to maintain a uniform temperature of the sealant and heating oil. Direct heating is not permitted. Thermometers should be provided for continuous temperature readings of both the oil and the sealant.

Appendix B
Proposed Specification for Low Modulus, Hot-Applied, Jet-Fuel-Resistant Pavement Joint Sealants for Rigid Pavements[1]

1. SCOPE: This specification covers low modulus, hot-applied, jet-fuel-resistant pavement joint sealant materials for use in sealing joints and cracks in rigid pavements that are exposed to cold ambient temperatures.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issues in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Federal Specification

PPP-P-704 - Pails, Metal: (Shipping, Steel, 1 through 12 Gallons)

Federal Standards

FED-STD-123 - Marking for Shipment (Civil Agencies)
FED-STD-313 - Material Safety Data Sheets Preparation and the Submission of

Military Standards

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129 - Marking for Shipment and Storage
MIL-STD-147 - Palletized Unit Loads

[1] This proposed specification has not been finalized and changes may occur before it is published as a material specification. Therefore, it's use may not be applicable for project specifications.

Federal Regulations

29 CFR 1900-1999 - Occupational Safety and Health Administration (OSHA), Department of Labor

2.2 *Other publications.* The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bid or request for proposal shall apply.

American Society for Testing and Materials (ASTM)

D 5 - Penetration of Bituminous Materials, Test Method for
D 140 - Sampling Bituminous Materials, Methods of
D 217 - Cone Penetration of Lubricating Grease, Test Method for
D 471 - Rubber Property - Effect of Liquids, Test Method for
D 1985 - Preparing Concrete Blocks for Testing Sealants for Joints and Cracks, Standard Practice for
D 5167 - Melting of Hot-Applied Joint and Crack Sealant and Filler Material for Evaluation, Standard Practice for

Technical Association of the Pulp and Paper Industry

T431 om - Ink Absorbency of Bottling Paper

2.3 *Order of Precedence.* In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall have precedence.

3. REQUIREMENTS

3.1 *Description.*

3.1.1 *Material.* The sealant shall be a thermoplastic material. It shall be composed of a mixture of coal tar, and rubber or resin, with additives. The manufacturer's specified application or pouring temperature shall not exceed 232 deg (°C) (450 deg (°F)), and shall be at least 11°C (20°F) lower than the safe heating temperature. The sealant shall meet the requirements of this specification when poured after held at the application temperature for no more than 10 min, and shall retain all of its properties with up to 3 hr of continuous heat.

3.1.2 *Performance.* The sealant shall form a resilient and adhesive compound, resistant to the solvent action of jet fuels and lubricating oils. The sealant shall effectively seal joints and cracks in pavements against the infiltration of moisture throughout repeat cycles of expansion and contraction. The sealant shall not flow from the joint or be picked up by pneumatic tires at ambient temperatures of 52°C (125°F) or below. The sealant shall have a uniform application or pouring consistency suitable for filling the joint or crack without the inclusion of blisters, bubbles, or discontinuities.

3.2 *Safe Heating Temperature.* The safe heating temperature is the highest use temperature permitted by the manufacturer (see 5.3.3) and is a temperature to which the sealant can be heated for a duration of at least 3 hr, and still conform to all of the requirements specified herein.

3.3 *Penetration.*

3.3.1 *Nonimmersed Penetration.* The nonimmersed penetration shall not exceed 16.0 millimeters (mm) (160 test units) (0.630 in.) when the sealant is tested as specified in 4.4.3.1.

3.3.2 *Fuel-Immersed Penetration.* The fuel-immersed penetration shall not exceed the nonimmersed penetration when the sealant is tested as specified in 4.4.3.2.

3.3.3 *Aged Penetration Retention.* The aged penetration retention shall be a minimum of 70 percent when tested as specified in 4.4.3.3.

3.4 *Change in Mass by Fuel Immersion.* The change in dry mass after fuel immersion for 24 hr at 49°C (120°F) shall not exceed 1.0 percent, and there shall be no apparent defects that will affect the material as a sealant when the sealant is tested as specified in 4.4.4.

3.5 *Flow.* Flow shall not exceed 3.0 mm (0.118 in.), for either specimen when tested as specified in 4.4.5.

3.6 *Bond to Concrete.*

3.6.1 *Nonimmersed Bond.* When the sealant is tested as specified in 4.4.6.4, the following requirements shall be met:

a. Two of the three specimens shall exhibit no crack, separation, or other opening in the sealant, or between the sealant and the concrete blocks.

b. The third specimen shall exhibit no crack separation, or other opening in the sealant, or between the sealant and the concrete blocks exceeding 6.35 mm (0.25) in depth, and shall exhibit no total area of bare concrete exposed on the face of either single concrete block exceeding 160 mm^2 (0.25 $in.^2$).

3.6.2 *Fuel-Immersed Bond.* When the sealant is tested as specified in 4.4.6.5, the following requirements shall be met:

a. None of the three specimens shall exhibit any crack, separation, or other opening in the sealant, or between the sealant and the concrete blocks exceeding 6.35 mm (0.25 in.) in depth.

b. None of the three specimens shall exhibit a total area of bare concrete exposed on the face of any single concrete block exceeding 160 mm^2 (0.25 $in.^2$).

3.6.3 *Water-Immersed Bond.* When the sealant is tested as specified in 4.4.6.6, requirements a. and b. of 3.6.1 shall be met.

3.7 *Resilience.* Recovery shall be a minimum of 45 percent when the sealant is tested as specified in 4.4.7.

3.8 *Storage Stability.* When specified (see 6.2), the user agency will retain samples for verification of these requirements: The sealant, when stored for 2 years from date of delivery, at temperatures from -18°C to 46°C (0°F to 115°F), and tested in accordance with this specification, shall meet all of the requirements herein.

3.9 *Toxicity.* The material shall have no adverse effect on the health of personnel when used for its intended purpose in the manner recommended by the manufacturer. Questions pertinent to this effect shall be referred by the acquiring activity to the appropriate medical service who will act as advisor to the acquiring activity. The manufacturer's instructions shall provide personnel protection to meet OSHA requirements, including 29 CFR 1910.1000, 1910.1002, and 1910.1017, as applicable (see 4.5).

3.10 *Material Safety Data Sheets (MSDS).* MSDSs shall be prepared in accordance with FED-STD-313 and submitted as directed (see 6.2, 6.3, and 6.5).

4. QUALITY ASSURANCE PROVISIONS

4.1 *Responsible for Inspection.* Unless otherwise specified, the contractor is responsible for the performance of all inspection requirements and may use his own or any other facilities suitable for the performance of the inspection requirements that are approved by the user agency. The user agency reserves the right to perform any inspections set fort in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 *Materials Inspection.* The contractor is responsible for insuring that supplies and materials are inspected for compliance with all the requirements specified herein and in applicable referenced documents.

4.2 *Classification of Inspections.* The inspection requirements specified herein are classified as follows:

a. Quality conformance inspection (see 4.2.1).

b. Inspection of preparation for delivery (see 4.6).

4.2.1 *Quality Conformance Inspection.* The quality conformance inspection shall be as specified in 4.4. Sampling shall be in accordance with 4.3.

4.3 *Sampling.* Unless otherwise specified (see 6.2), samples for testing shall be taken at the point of manufacturer in accordance with ASTM D 140. It

shall be the responsibility of the contractor to determine that the samples taken are representative of the batches for shipment. The representative composite sample of the sealant shall consist of not less than 7 kg (15 lb) from each batch. A lot consisting of a single batch, if taken from filled containers, shall be sampled from 3 containers, selected at random, to make up the composite sample. Sample identification shall include the name of the testing agency, the contract or purchase order number, and special marking as specified in 5.3.3. Each container from which sample material has been taken shall be resealed and marked for identification.

4.4 *Testing*. Testing shall be conducted at a user-agency approved facility (see 6.2). Samples taken as specified in 4.3 shall be tested as specified in 4.4.1 through 4.4.7. Individual test values, and results of failure analyses of individual shall be recorded. Failure of the sealant to pass any test shall be cause for rejection of the lot, except as noted for bond specimen casting defects in 4.4.6.3, and as noted for a marginal test result. The exceptions for marginal test results are as follows: where test results of only one of the specified tests are judged by the testing agency to be marginal as to meeting the requirements, the testing agency has the option to perform a retest. If the testing agency does not exercise its option to retest, either the contractor of the user agency may request that a retest for that property be made at the requester's expense. Such a test will be made only when an adequate quantity of the original sample is available or where additional material can be obtained from the previously marked sample containers.

4.4.1 *Standard Conditions*. Laboratory atmospheric conditions, hereinafter referred to as standard conditions, shall be a temperature of $23 \pm 2°C$ ($73 \pm 4°F$) and 50 ± 5 percent relative humidity. Specimens shall be stored and tested at standard laboratory conditions unless otherwise specified.

4.4.2 *Specimen Preparation.*

4.4.2.1 *Equipment*. The unit for melting the laboratory samples shall be as specified in ASTM D 5167.

4.4.2.2 *Melting*. The portion of the sample selected for testing shall provide approximately 1.6 cubic decimeter (1.7 quarts) of melted material. The portion of material selected shall be obtained from the original sample and melted as specified in ASTM D 5167. The sample shall be heated at the safe heating temperature until 3 hr have elapsed since the first segment was added to the melters.

4.4.2.3 *Pouring*. Pour all test specimens as specified in 4.4.5 through 4.4.7 within a period of 10 min. Discard the first 50 to 60 g of material discharged from each melting pot. After pouring, store all specimens at standard laboratory conditions for 72 ± 4 hr prior to beginning testing or initiating fuel or water immersion procedures.

4.4.3 *Penetration.*

4.4.3.1 *Nonimmersed Penetration.* Testing shall be as specified in ASTM D 5 except as specified herein. Use a penetrometer as specified in ASTM D 217 with a cone conforming to the Optional Cone therein in place of the needle. Prepare specimen in 177 cc (6 oz) container, and cast flush with the top edge. Make determinations at location on 120° radii, and halfway between the center and outside of the specimen. Determine conformance to the requirements of 3.3.1.

4.4.3.2 *Fuel-Immersed Penetration.* Immerse specimens prepared as specified in 4.4.3.1, for 24 hr in 500 cc (16.9 oz) each of clean test fuel maintained at 49±1°C (120±2°F). The container for the test fuel and specimens shall have a 3.2 mm (0.125 in.) round hole cut in the lid to eliminate pressure build-up. More than one specimen of the same manufacturer's material may be immersed in the same container, provided the volume of test fuel per specimen is maintained at 500 cc. The container shall be deep enough to provide a minimum cover of test fuel of 12.7 mm (0.5 in.) over the specimens. Use a covered constant temperature water bath to maintain the container, specimens and test fuel at the required temperature. The test fuel shall be a 70 percent isooctane/30 percent toluene composition, by volume, conforming to the requirements of ASTM Reference Fuel B of ASTM D 471 (see 6.6.2). Immediately after the 24-hr immersion period, dry the specimens for 1 hr under a 300 mm (12 in.) diameter electric fan, placed to provide an air speed of 0.76 to 2.54 meters per second (m/s) (150 to 500 ft per min (f/m)) over the surface of the specimens. Test as specified in 4.4.3.1. Determine conformance to the requirements of 3.3.2.

4.4.3.3 *Aged Penetration Retention.* Prepare one specimen as specified in 4.4.3.1. Cure the specimen at standard laboratory conditions for 72±4 hr and then place the specimen in a forced-draft oven maintained at 70±1°C (158±2°F) for 72±1 hr. Remove the specimen from the oven and cool at standard laboratory conditions for 1 hr. Further condition the specimen for 1 hr in a constant temperature water bath maintained at 25±0.1°C (77±0.2°F). Determine the aged penetration as specified in 4.4.3.1. Calculate the aged penetration retention using the following formula:

$$\frac{\text{Oven Aged Penetration}}{\text{Nonimmersed Penetration}} \times 100 \text{ percent}$$

Determine conformance to the requirement of 3.3.3.

4.4.4 *Change in Mass by Fuel Immersion.* Prepare a specimen as specified in 4.4.3.1, in a tared container, and determine the mass to the nearest 0.01 g. Immerse and dry the specimen as specified in 4.4.3.2, and redetermine the mass. Report the change in mass of the specimen in percent gain or loss. Determine conformance to the requirements of 3.4.

4.4.5 *Flow.*

4.4.5.1 *Specimen Preparation.* Prepare duplicate specimens in molds with inside dimensions of 40 mm by 60 mm by 3.2 mm (1.56 in. by 2.34 in. by 0.125 in.), placed on a bright tin panel. Metal molds, coated with a release agent, such as a thin, cured film of heat-stable silicone (see 6.6.3), or equivalent, shall be used. Fill the molds with excess sealant and allow the specimens to cool at standard laboratory conditions for a minimum of 30 min. After the specimens have cooled, trim off the excess sealant flush with the face of the mold with a heated knife or spatula.

4.4.5.2 *Test.* Remove the molds and mark reference lines across the panels coincident with the transverse edges of the specimens. Mount the specimens with the long axis at an angle of $75 \pm 1°$ with the horizontal and the transverse axis horizontal, in a forced-draft oven maintained at $60 \pm 1°C$ ($140 \pm 2°F$). After 5 hr, remove the specimens and mark a reference line on each specimen coincident with the lowest point of sag or flow, and parallel to the reference line. Measure the indicated change in length of the specimen and report as flow. Determine conformance to the requirements of 3.4.

4.4.6 *Bond to Concrete.*

4.4.6.1 *Extension Machine.* The extension machine used in the bond testing shall be so designed that the specimen can be maintained at the test temperature while being extended at a uniform rate as specified. It shall consist essentially of one or more screws rotated by an electric motor through suitable gear reductions. Self-aligning plates or grips, one of each pair fixed and the other carried by the rotating screw or screws, shall be provided for holding the test specimen in position during the test.

4.4.6.2 *Concrete Block Preparation.* The concrete blocks used for bond testing shall be prepared as specified in ASTM D 1985. The blocks may be prepared by the testing agency or procured (see 6.6.3).

4.4.6.3 *Specimen Preparation.* Prepare 6 bond test specimens (12 blocks) as follows: Remove blocks from the storage water individually, scrub the 50 mm by 75 mm (2 in. by 3 in.) faces lightly with a stiff bristle brush, under running water, and resubmerge in fresh tap water until all blocks have been scrubbed. Remove all blocks from the water and lightly blot with an oil-free, soft, absorbent cloth or paper to remove all free surface water. Place the blocks, 3 each, with the 50 mm by 75 mm faces down, centered and uniformly spaced 25 mm (1 in.) apart on sheets of blotting paper placed on a plane, solid, nonabsorbent surface. The sheets shall be approximately 100 mm by 240 mm (4 in. by 9.5 in.), cut from material having a maximum absorption time of 28 sec as measured by TAPPI T431 (see 6.6.6). At the end of 1 hr, assemble pairs of concrete blocks to provide test specimens. Complete setup and pour specimens within 1 hr. Spacers and the base plate used for the test specimens shall have nonadherent, nonreactive surfaces (see 4.4 5.1). Place the spacer strips not less than 6.35 mm (0.25 in.) thick on a base plate to form an open space 12.7 mm (0.5 in.) wide and 50 mm

(2 in.) long. Place pairs of the concrete blocks on the spacers so that the 25 mm by 75 mm faces are on the spacers and the 50 mm by 75 mm faces which were against the blotter paper from the space to be filled by the sealant. Space the blocks 12.7±0.1 mm (0.500±0.005 in.) apart with 12.7±.1 mm square by 75 mm long spacers. Corners may be slightly rounded, but discard spacers that have a diagonal dimension less than 16.51 mm (0.650 in.). Place these spacer strips at a distance from the ends of the blocks so that an opening 12.7±0.1 mm by 50 mm by 50 mm (0.5±0.005 in. by 2 in. by 2 in.) is formed. Place spacer strips that are a minimum of 12.7 mm thick on top of the blocks to provide for an overfill. Clamps or other suitable means may be used to hold the blocks and overfill spacers in position. Pour sealant prepared in accordance with 4.4.2 into the space between the blocks in sufficient quantity to bring it at least even with the top of the overfill spacers, and in a manner to exclude air pockets from being trapped in the sealant. After the specimens have cooled to standard conditions, remove the excess sealant protruding beyond the top and bottom of the concrete blocks by trimming with a hot knife or spatula. If the material shrinks on cooling below the top of the blocks, or if other casting defects are apparent, discard the specimens and prepare additional ones. Cool the specimens at least 2 hr, but no more than 24 hr, at standard laboratory conditions before subjecting them to test conditions.

4.4.6.4 *Nonimmersed Bond.* Condition 3 bond test specimens, with spacers maintaining the 12.7 mm dimensions, at the test temperature of -29±1°C (-20±2°F), with forced air circulation, for 4 to 16 hr. Then extend the specimen 6.35 mm (0.25 in.) at a uniform rate of 3.18 mm (0.125 in.) per hr, while maintaining the specimens at the test temperature. Remove the specimens from the extension machine and reinsert the 12.7 mm spacers, and examine the spacers as described in 4.4.6.7. Then allow the specimens to return to the original dimensions at standard conditions, resting each specimen on one concrete block so that the weight of the top block recompresses the joint sealant. Three cycles of conditioning, extension, and recovery shall be complete within 5 days after the start of the first cycle, and shall constitute one complete test for the nonimmersed bond (see 4.4.6.7). When initiation of the second or third cycle is delayed, store the specimens at the test temperature.

4.4.6.5 *Fuel-Immersed Bond.* Insert thinner spacers between the concrete blocks of another three bond specimens, so that an opening of not less than 6.35 mm by 12.7 mm by 50 mm (0.25 in. by 0.5 in. by 2 in.) will be produced and maintained between the spacers and the sealant. Using the type containers and procedures described in 4.4.3.2, and the test fuel specified therein, immerse the specimens for 24±0.25 hr in 500 cc (16.9 oz) of the test fuel maintained at 49±1°C (120±2°F) by means of a constant temperature water bath. Place the specimens with the concrete blocks in a horizontal position. Three specimens may be placed in the same container, provided that the fuel-to-specimen ratio is maintained. At the end of the 24 hr immersion period, condition the entire assembly of test specimens, fuel, and container in an atmosphere at -29±1°C (-20±2°F) for 4 hr. Remove the test specimens from the fuel, remove the spacers, and conduct the extension test as specified

in 4.4.6.4. One cycle of immersion and three cycles of conditioning, extension, and recovery shall constitute one complete test of water-immersed bond (see 4.4.6.7).

4.4.6.6 *Water-Immersed Bond.* Insert thinner spacers between the concrete blocks of the remaining three bond specimens, so that an opening of not less than 6.35 mm by 12.7 mm by 50 mm (0.25 in. by 0.5 in. by 2 in.) will be produced and maintained between the spacers and the sealant. Using covered containers deep enough to provide a minimum of 12.7 mm water cover, immerse the specimens for 96 hr in 500 cc (16.9 oz) of distilled or deionized water per specimens with the concrete blocks in a horizontal position. Three specimens may be placed in the same container, provided that the water-to-specimen ratio is maintained. At the end of the 96 hr immersion period, remove the excess surface water from the specimens with a soft, dry, absorbent material. Subject the specimens to conditioning and extension test as specified in 4.4.6.4. One cycle of immersion and three cycles of conditioning, extension, and recovery shall constitute one complete test for water-immersed bond (see 4.4.6.7).

4.4.6.7 *Bond Test Results.* Remove the bond test specimens from the extension machine within 30 min after the completion of the extension of each of the first two test cycles and examine the specimens for obvious separations within the sealant and between the sealant and the concrete blocks without distorting or manually causing extension of the specimens. Immediately upon completion of the final cycle, insert both sets of spacers or otherwise maintain 50 percent extension during examination and dimensional measurements, examining the specimens thoroughly, while still frozen, for separations between the sealant and concrete blocks and within the sealant, including surface cracks. This shall be accomplished without distorting the specimens, but after recovery as specified in 4.4.6.4, the specimens may be extended uniformly up to 25.4 mm (1 in.) to permit further detailed examination. Determine conformance to the requirements of 3.6.1, 3.6.2, and 3.6.3.

4.4.7 *Resilience.*

4.4.7.1 *Specimen Preparation.* Prepare one specimen as specified in 4.4.3.1, except cure the specimens for 72 ± 4 hr at standard laboratory conditions prior to testing. Condition the specimen for 1 hr in a water bath maintained at $25 \pm 0.3°$ ($77 \pm 0.5°$F) prior to testing.

4.4.7.2 *Procedure.* Use a penetrometer as specified in ASTM D 217, substituting the ball penetration tool illustrated in Figure 1 of ASTM D 217 for the needle. Lightly dust the surface of the specimen with talc and immediately remove the excess by blowing. Place the ball in contact with the surface of the specimen and set the indicating dial to zero. Position a light so that initial contact of the ball with the specimen surface can be readily observed. Release the ball penetration tool and allow the ball to penetrate the specimen for 5 sec. Record this reading as penetration (P) in tenth-millimeter units. Without returning the dial pointer to zero, press the ball penetration tool down for an additional 100 units (i.e., to a dial reading of P+100) at a uniform rate within

10 sec. Re-engage the clutch to hold the ball in this position for 5 sec and during this time return the indicator dial to zero. Release the clutch, allow the specimen to recover for 20 sec, and record the final dial reading (F). Make determinations at 3 points equally spaced from each other and not less than 13 mm (0.5) inch) from the container rim. Calculate the recovery, a measure of resilience, as follows:

$$\text{Recovery, percent} = P + 100 - F$$

Report the average of 3 determinations of recovery for the specimen. Determine conformance to the requirements of 3.7.

4.5 *Toxicological Data and Formulations.* The manufacturer shall provide a listing of the components in the sealant that when heated could produce hazardous vapors (see 5.3.3). Where precautions need to be taken relative to the inhaling of, or skin or eye contact with the material or vapors, these precautions shall be included in the manufacturer's instructions (see 3.9 and 5.3.3.1).

4.6 *Inspection of Preparation for Delivery.*

4.6.1 *Sampling.* Sampling for inspection of filled containers shall be in accordance with MIL-STD-105, inspection Level II. The unit of product shall be one unit prepared for shipment.

4.6.2 *Examination.* Each filled container selected shall be inspected for conformance to the requirements of Section 5. Inspection shall be based on an acceptable quality level of 2.5 percent defective.

5. PREPARATION FOR DELIVERY

5.1 *Packing.* Packing shall be Level A, B, or commercial as specified (see 6.2).

5.1.1 *Level A.* The material shall be packed in a close-fitting tapered 24-gage metal pail with gasket and lug cover. Pails shall have a wire handle securely attached to ears or clips which shall be attached to the body of the pails. The exterior surfaces of the pails shall be coated as specified in PPP-P-704. The unit pack quantity shall be one unit of issue quantity specified in the contract or purchase order.

5.1.2 *Level B.* The material shall be packed the same as for Level A except that the exterior surfaces of the pail shall be coated with a commercial coating.

5.1.3 *Commercial.* The material shall be packed to insure carrier acceptance and safe delivery to the destination in containers complying with the rules and regulations applicable to the mode of transportation.

5.2 *Palletization.*

5.2.1 *Level A.* Unless otherwise specified (see 6.2), material shall be palletized in accordance with MIL-STD-147.

5.2.2 *Level B and Commercial.* When specified (see 6.2), material shall be palletized in accordance with MIL-STD-147.

5.3 *Marking.*

5.3.1 *Civil Agencies.* Shipments to civil agencies shall be marked in accordance with MIL-STD-123.

5.3.2 *Military Agencies.* Shipments to military agencies shall be marked in accordance with MIL-STD-129.

5.3.3 *Special Marking.* In addition to the marking of 5.3.1 or 5.3.2, and any special marking of the contract or order, the following information shall be shown on each pail:

a. Name of sealant

b. Specification number

c. Manufacturer's name and material designation

d. Manufacturer's lot and batch number

e. Date of manufacturer (month and year)

f. List of hazardous components (see 4.5)

g. Quantity of sealant in pail (net weight)

h. Application or pouring temperature

i. Safe heating temperature

j. Instructions for use

5.3.3.1 *Instructions for Use.* The instructions for use (see 6.7) shall include, but not limited to the following: ambient temperature and humidity ranges, and moisture conditions of joints, for successful installation; essential requirements for preparation of joints, heating of the sealant, handling, placing, and disposal of hot materials; and any restrictions to be adhered to in order to reduce hazards to personnel or to the environment. If it is not feasible to include all the instructions on the container without sacrificing legibility, the most important information shall be shown on the container and the full instructions referenced and furnished separately.

6. NOTES

6.1 *Intended Use.* This sealant is intended for sealing joints and cracks in rigid pavements that are subjected to the spillage of jet fuels and lubricating oils. It is not intended to be resistant to the heat and blast of jet aircraft engines, except when aircraft are moving at moderate speeds.

6.2 *Ordering Data.* Purchasers shall select the preferred options permitted herein, and include the following in procurement documents:

a. Title, number, and date of this specification

b. When stability samples are required, quantity to be retained and by what activity (see 3.7 and 6.4)

c. Addresses for submission of MSDS (see 3.9 and 6.5)

d. Sampling, if other than as specified (see 4.3)

e. Designation of Government approved test facility (see 4.4)

f. Level of packing required (see 5.1)

g. If palletization is not required for Level A (see 5.2.1)

h. When palletization is required for Level B or commercial (see 5.2.2)

6.3 *Data Requirements.* When this specification is used in an acquisition which incorporates DD Form 1423, Contract Data Requirements List (CDRL) and invokes the provisions of paragraph 52.227-7031 of the Federal Acquisition Regulations (FAR), the data requirements will be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL (DD Form 1423) incorporated into the contract. When the provisions are not invoked, the data shall be delivered in accordance with the contract requirements (see 3.10).

6.4 *Stability Samples.* The date of delivery shall be marked on samples submitted for stability testing (see 3.7)

6.5 *MSDS Submission and Forwarding.* MSDS copies shall be forwarded to the designated Industrial Hygienist and the focal point of the activity that purchased the item, and the focal point of the using activity if different from purchase activity. After review and acceptance of MSDS by designated recipients, approved copies will be forwarded to arrive at the destinations prior to material delivery (see 3.9).

6.6 *Availability of Testing Materials and Apparatus.* Known suppliers of specified testing materials and apparatus are as follows:

6.6.1 *Melting Unit.* A unit as specified in 4.4.2.1: Laboratory Melter Model BLM-100, Berry Corporation, P.O. Box 337, Nicholas, KY 40356.

6.6.2 *Reference Fuel.* Reference fuel as specified in 4.4.3.2: ASTM Reference Fuel B of ASTM D 471, Phillips Petroleum Company, Customer Service Center, Drawer "O", Borger, TX 79007.

6.6.3 *Release Agent.* An agent as specified in 4.4.5.1: Dow Corning 20 release coating, Dow Corning Corporation, Midland, MI 48640.

6.6.4 *Concrete Blocks.* Blocks as specified in 4.4.5.1: U.S. Army Corps of Engineers, Missouri River Division Laboratory, 420 South 18th Street, Omaha, NE 68102.

6.6.5 *Blotting Paper.* Paper as specified in 4.4.6.3: White Reliance Blotting Paper, Product Code 13-01-12, James River Paper Company, Incorporated, 145 James Way, Southhampton, PA 18966.

6.7 *Precautions.* The sealant material can be damaged by heating at too high a temperature, reheating, or by heating for too long a period of time. The temperature of the sealant in the melting equipment should never exceed the safe heating temperature set by the manufacturer. Any given quantity of material should never be heated at the application or pouring temperature for more than 3 hr and should never be reheated. Sealant material left in the equipment at the end of the working day should be removed and discarded. The sealant should be heated in a kettle or tank constructed as a double boiler, with the space between the inner and outer shells filled with heat transfer oil. Positive thermostatic control, mechanical agitation, and recirculating pumps should be provided to maintain a uniform temperature of the sealant and heating oil. Direct heating is not permitted. Thermometers should be provided for continuous temperature readings of both the oil and the sealant.

Appendix C
Data Sheets and Specification Conformance Test Results for Sealant Materials Used in the Field Evaluation

Note: All information provided in this appendix was summarized from information supplied by the joint sealant manufacturers unless otherwise noted. For additional information concerning the products and Material Safety Data Sheets, please contact the specific manufacturer. The citation of trade names and/or product names does not constitute an official endorsement or approval of the use of these products.

Manufacturer: Crafco, Inc., 6975 West Crafco Way, Chandler, AZ 85226, Telephone: (800) 528-8242 or (602) 276-0406, Fax: (602) 961-0513.

Sealant: RoadSaver 222

General Information: RoadSaver 222 is a single component, hot-applied, petroleum-based pavement crack and joint sealant material which can be used to seal the joints or cracks in both rigid and flexible pavements. RoadSaver 222 is manufactured to meet the requirements of Federal Specification SS-S-1401C and to exceed the requirements of ASTM D 1190, ASTM D 3405, AASHTO M173, and AASHTO M301. RoadSaver 222, when properly applied, should remain flexible and extendible at sub-zero temperatures and resist tracking at high summer temperatures.

Physical Properties: Typical physical properties and Federal Specification SS-S-1401C results are provided below. The test results do not infer that all lot or batch numbers of RoadSaver 222 will in fact comply with the requirements of Specification SS-S-1401C.

Test	Typical Properties	Test Results for Lot Number Used in Field Evaluation	Federal Specification SS-S-1401C Requirements
Cone penetration, 77°F	7.5 mm	7.8 mm	9.0 mm max.
Flow, 140°F	1 mm	0.5 mm	3.0 mm max.
Resilience, 77°F			
Unaged			
Indentation	0.08 cm	0.11 cm	0.05-0.15 cm
Recovery	70%	73%	60% min.
Aged			
Indentation	0.08 cm	0.10 cm	0.05-0.15 cm
Recovery	65%	64 %	60% min.
Bond testing, -20°F, 50% extension			
Nonimmersed	Pass	Pass 3 cycles	Pass 3 cycles
Water immersed	Pass	Pass 3 cycles	Pass 3 cycles
Compatibility	Pass	Pass	Pass
Recommended pour temp.	380°F	380°F	N/A
Safe heating temp.	410°F	410°F	As recommended
Brookfield viscosity at 380°F, ASTM D 3236	40 Poise	[1]	N/A
Ductility, 77°F ASTM D 113	50 cm	[1]	N/A
Softening Point, ASTM D 36	190°F	[1]	N/A
Unit weight at 60°F	9.6 lb/gal	[1]	N/A
Coverage 1/2 in. x 1/2 in. joint	12.5 lb/100 ft		N/A

[1] Manufacturer did not provide test data on lot number used for the field evaluation.

Manufacturer: Crafco, Inc., 6975 West Crafco Way, Chandler, AZ 85226, Telephone: (800) 528-8242 or (602) 276-0406, FAX: (602) 961-0513.

Sealant: Improved Non-Fuel-Resistant Sealant

General Information: The manufacturer had not developed or provided a product data sheet on this material because it was formulated for the field evaluation. The Improved Non-Fuel-Resistant material is a single component, hot-applied petroleum-based pavement crack and joint sealant material which can be used to seal the joints or cracks in both rigid and flexible pavements. This sealant is manufactured to meet the requirements of a proposed non-fuel-resistant specification (See Appendix A). The sealant is formulated to maintain a greater amount of flexibility and extensibility at sub-zero temperatures and resist tracking at high summer temperatures.

Physical Properties: Typical physical property test results provided by the manufacturer are given below. Generally, this sealant will have a lower modulus than typical sealants manufactured to meet the requirements of Federal Specification SS-S-1401C.

Test Results for Pilot Production of Batch of Mixture 230-3		
Requirement	**Result**	**Specification Limits**
Penetration, mm	12.7	9.0 -15.0
Flow, mm	0.0	3.0 max
Resilience, percent Indentation, mm	73 2.8	50 - 80 1.0 - 3.5
Aged Resilience, percent Indentation, mm	67 2.6	50 - 80 1.0 - 3.5
Bond to concrete, Nonimmersed Water immersed	 Satisfactory Satisfactory	 Satisfactory Satisfactory
Static adhesion	Satisfactory	Satisfactory
Compatibility	Satisfactory	Satisfactory

Manufacturer: Crafco, Inc., 6975 West Crafco Way, Chandler, AZ 85226, Telephone: (800) 528-8242 or (602) 276-0406, FAX: (602) 961-0513.

Sealant: RoadSaver Silicone SL Sealant

General Information: RoadSaver Silicone Sealant is a single component, low modulus, moisture curing system formulated to provide a flexible seal for joints in portland cement concrete (PCC) pavements. RoadSaver Silicone Sealant offers weathering resistance and flexibility to temperatures as low as -50°F.

Physical Properties: Typical physical properties are provided below. An industry accepted material specification does not exist for pavement silicone joint sealant materials; therefore, the specification limits listed below are those recommended by Crafco, Inc. These results do not infer that all lot numbers of RoadSaver Silicone SL Sealant will conform to the specified requirements.

Results for RoadSaver Silicone SL Sealant Used in Fairchild AFB Test Section

Uncured Properties	Test Results	Recommended Specification
Extrusion Rate (Mil 8802)	730 g/min.	450-750 g/min.
Skinover Time[1]	65 min.	2 hours min.
Leveling at 77°F (ASTM C639)	Pass	Pass
Cured Properties	**Test Results**	**Recommended Specifications**
Through Cure Time, 1/2" x 1/2"[1]	7 days	21 day max.
Elongation (ASTM D412-C)[2]	825%	800% max.
Stress at 150% (ASTM D412-C)[2]	19 psi	30 psi max.
Shore OO Hardness (ASTM D2240)[2]	63	40-80
Specific Gravity (ASTM D792-A)[2]	1.28	1.10-1.40
Adhesion to Concrete (Mil 8802)[3]	25 pli +	20 pli min.
Bond and Movement Capability[3] ±50% (ASTM C719)	Pass 10 cycles	Pass 10 cycles
Accelerated Weathering (ASTM C793)[2]	Pass 5,000 hours	Pass 5,000 hours
Bond to Mortar (AASHTO T132)[3]	75 psi +	50 psi min.
Tensile Adhesion % Elongation[4] ASTM D3583 (section 14 modified)	825%	600%

[1] Tested at 77 ± 3°F and 50 ± 5% humidity.
[2] Specimens shall be obtained from 1/8 in. thickness sheets of material which has been cured for 21 days at 77 ± 3°F and 50 ± 5% relative humidity.
[3] Specimens cured for 28 days at 77 ± 3°F and 50 ± 5% humidity.
[4] Specimen shall be 1/2" x 1/2" cured 21 days at 77 ± 3°F and 50 ± 5% humidity.

Manufacturer: Crafco, Inc., 6975 West Crafco Way, Chandler, AZ 85226, Telephone: (800) 528-8242 or (602) 276-0406, FAX: (602) 961-0513.

Sealant: Superseal 1614A

General Information: Superseal 1614A is a hot-applied, pavement joint sealant material which can be used to seal the joints or cracks in rigid pavements that are exposed to fuel spillage. Superseal 1614A is manufactured to meet the requirements of Federal Specification SS-S-1614A, ASTM D 3581, and ASTM D 1854. Superseal 1614A is supplied in liquid form and when heated and applied into the joint, cools to form a tough and resilient seal. Superseal 1614A should not be used to seal cracks in asphaltic pavements.

Physical Properties: Typical physical properties and Federal Specification SS-S-1614A results are provided below. The test results do not infer that all lot or batch numbers of Superseal 1614A will in fact comply with the requirements of Federal Specification SS-S-1614A.

Test	Typical Properties	Test Results for Lot Number Used in Field Evaluation	Federal Specification SS-S-1614A Requirements
Cone penetration, 77°F	1.15 cm	1.17 cm	1.30 cm max.
Fuel-immersed penetration, 77°F	1.00 cm	0.96 cm	1.55 cm max.
Flow, 140°F	0.0 cm	0.0 cm	3.0 cm max.
Bond testing, -20°F, 50% extension			
Nonimmersed	Pass	Pass	Pass 3 cycles
Water immersed	Pass	Pass	Pass 3 cycles
Fuel-immersed	Pass	Pass	Pass 3 cycles
Change-in-weight	-0.3%	-0.68%	±2.0%
Recommended pour temp.	250°F	250°F	N/A
Safe heating temp.	270°F	270°F	As recommended
Brookfield viscosity at 270°F, ASTM D 3236	45 Poise	[1]	N/A
Unit weight at 60°F	10 lb/gal		N/A
Coverage 1/2 in. x 1 in. joint	26 lb/100 ft		N/A

[1] Manufacturer did not provide test data on lot number used for the field evaluation.

Manufacturer: Crafco, Inc., 6975 West Crafco Way, Chandler, AZ 85226, Telephone: (800) 528-8242 or (602) 276-0406, FAX: (602) 961-0513.

Sealant: Improved Jet-Fuel-Resistant Sealant

General Information: The manufacturer had not developed or provided a product data sheet on this material because it was formulated during the CPAR laboratory evaluation. The Improved Jet-Fuel-Resistant material is a single component, hot-applied, pavement crack and joint sealant material which can be used to seal the joints or cracks in rigid pavements that will be exposed to fuel spillage. This sealant is manufactured to meet the requirements of a proposed jet-fuel-resistant specification (See Appendix B). The sealant is formulated to maintain a greater amount of flexibility and extensibility at low temperatures and resist tracking at high summer temperatures. This sealant should not be used to seal cracks in asphaltic pavements.

Physical Properties: Typical physical property test results were provided by the manufacturer. Generally, this sealant will have a lower modulus than typical sealants manufactured to meet the requirements of Federal Specification SS-S-1614A.

Test Results of Mixture CP-87 Pilot Production Batch

Test	Results	Specification Requirements
Nonimmersed penetration	13.5	16.0 mm max
Fuel-immersed penetration	11.3	Not greater than nonimmersed
Aged penetration retention	87 percent	70 percent min
Change in mass by fuel-immersion	-0.1 percent	± 1.0 percent max
Flow	0.0	3.0 mm max
Bond to concrete		
Nonimmersed	Satisfactory	Satisfactory
Fuel-immersed	Satisfactory	Satisfactory
Water immersed	Satisfactory	Satisfactory
Resilience	65 percent	45 percent min

Manufacturer: Dow Corning Corporation, 3901 S. Saginaw Road, Midland, MI 48686-0994, Telephone: (800) 248-2481

Sealant: Dow Corning[1] 890-SL Self-Leveling Silicone Joint Sealant

General Information: Dow Corning 890-SL i: a single component, ultra-low modulus, moisture curing joint sealant formulated to provide a flexible seal for joints or cracks in portland cement concrete (PCC) and asphaltic pavements. Dow Corning 890-SL offers weathering resistance and remains elastic and rubbery from -50°F to 300°F without tearing or cracking.

Physical Properties: Typical physical properties are provided below. An industry accepted material specification does not exist for pavement silicone joint sealant materials; therefore, the test procedures listed below are those recommended by Dow Corning Corporation. These results do not infer that all lot numbers of 890-SL will conform to the specified requirements.

Test[1]	Typical Properties	Test Results for Lot Number Used in Field Evaluation
As Supplied		
Color	Charcoal gray	Charcoal gray
Through cure time	14-21 days	[2]
Flow, sag or slump	Self-leveling	Self-leveling
Viscosity	120 Poise	[2]
Extrusion rate	400 grams/min	309 grams/min
Percent solids	97 percent	97 percent
Specific gravity	1.3-1.4	1.277
Working time	15 min	[2]
Skin-over-time at 77°F	30 min (60 min max.)	18 min
Achieves full adhesion	14-21 days	[2]
After 21 days cure at 77°F and 50 percent Rh		
Elongation	1,400 minimum	1600 percent
Modulus at 50 percent elongation	7 psi maximum	2 psi
Modulus at 100 percent elongation	8 psi maximum	5 psi
Modulus at 150 percent elongation	9 psi maximum	5 psi
Durometer hardness, Shore 00	40	50
Adhesion to concrete elongation	+600 percent min	1152 percent
Adhesion to asphalt elongation	+600 percent min	[2]
Coverage, 1/4 in. x 1/4 in. sealant bead 3/8 in. x 1/4 in. sealant bead 3/4 in. x 3/8 in. sealant bead	 275 ft/gal 185 ft/gal 60 ft/gal	 N/A N/A N/A

[1] The manufacturer prefers the specification writers contact Dow Corning Corporation before writing specifications for this product.
[2] Test results not provided by the manufacturer.

[1] "Dow Corning" is a registered trademark of Dow Corning Corporation.

Manufacturer: Dow Corning Corporation, 3901 S. Saginaw Road, Midland, MI 48686-0994, Telephone: (800) 248-2481

Sealant: Dow Corning[1] 902 RCS Joint Sealant

General Information: Dow Corning 902 RCS (rapid cure silicone) is a two-component, ultra-low modulus, self-leveling, rapid curing system formulated to provide a flexible seal for expansion joints that experience both thermal and vertical movements due to traffic loading. Dow Corning 902 RCS offers weathering resistance and remains elastic and rubbery from -45°F to 300°F without tearing or cracking.

Physical Properties: Typical physical properties are provided below. An industry accepted material specification does not exist for pavement silicone joint sealant materials; therefore, the test procedures listed below are those recommended by Dow Corning Corporation. These results do not infer that all lot numbers of 902 RCS will conform to the specified requirements.

Test[1]	Typical Properties Part A	Part B	Test Results for Lot Number Used in Field Evaluation Part A	Part B
As Supplied				
Color	Black	White	Black	White
Flow, sag or slump	Self-leveling		Self-leveling	
Extrusion rate	200-550 grams/min		[2]	287
Specific gravity	1.3-1.4		1.281	1.296
After 21 days cure at 77°F and 50 percent Rh				
Skin-over time	10-15 min		9 min	
Tack-free time	30-60 min		[2]	
Elongation[3]	600 percent minimum			
Modulus at 100 percent elongation	3-8 psi		7.9 psi	
Cure rate, percent total cure 50 percent cure 75 percent cure 100 percent cure	 4-6 hr 24 hr 48-160 hr		 N/A N/A N/A	
Coverage, 1 in. x 1/2 in. sealant bead	14 ft[4]		N/A	

[1] The manufacturer prefers that specification writers contact Dow Corning Corporation before writing specifications for this product.
[2] Test results not provided by the manufacturer.
[3] Joint size is 1/2 in. by 1/2 in. by 2 in.
[4] Based on one kit containing two 26 ounce E-Z PAK[1] sausages.

[1] "Dow Corning" and E-Z PAK are registered trade marks of Dow Corning Corporation.

Manufacturer: Koch Materials Company, P.O. Box 510, Highway 66 East, Stroud, OK 74079, Telephone: (800) 654-9182 or (918) 968-3541.

Sealant: Product 9005

General Information: Product 9005 is a single component, hot-applied pavement crack and joint sealant material which can be used to seal the joints or cracks in both rigid and flexible pavements. Product 9005 is manufactured to meet the requirements of Federal Specification SS-S-1401C, ASTM D 3405, AASHTO M-301-851, and FAA Specification P-605, Type III. Product 9005, when properly applied, should form a resilient and adhesive material that will seal joints and cracks against moisture infiltration while remaining flexible at low temperatures and will not flow from the joint at ambient temperatures.

Physical Properties: Typical physical properties and Federal Specification SS-S-1401C results are provided below. The test results do not infer that all lot or batch numbers of Product 9005 will in fact comply with the requirements of Federal Specification SS-S-1401C.

Test	Typical Properties	Test Results for Batch Used in Field Evaluation	Federal Specification SS-S-1401C Requirements
Cone penetration, 77°F	7.7 mm	7.7 mm	9.0 mm max.
Flow, 140°F	0 mm	1.0 mm	3.0 mm max.
Resilience, 77°F Unaged Indentation Recovery[2] Aged Indentation Recovery	 [1] 70 percent [1] 65 percent	 0.1 cm 70 percent 0.09 cm 68 percent	 0.05-0.15 cm 60 percent min. 0.05-0.15 cm 60 percent min.
Bond testing, -20°F, 50 percent extension Nonimmersed Water immersed	 Pass [1]	 Pass Pass	 Pass 3 cycles Pass 3 cycles
Compatibility[2]	Pass	Pass	Pass
Recommended pour temp.	370°F	370°F	N/A
Safe heating temp.	390°F	390°F	As recommended
Nonimmersed bond, 0°F, 100 percent extension	Pass	[1]	N/A
Brookfield viscosity at 370°F at 390°F	 88 Poise 50 Poise	 [1] [1]	 N/A N/A
Ductility, 39.2°F ASTM D 113	40 cm	[1]	N/A
Softening point, ASTM D 36	190°F	[1]	N/A
Unit weight	9.8 lb/gal	[1]	N/A
Coverage 1/2 in. x 1/2 in. joint	12.3 lb/100 ft		N/A

[1] Not provided in manufacturer's literature or specific test results.
[2] Manufacturer's data provided for testing as conducted in ASTM D 3407.

Manufacturer: Koch Materials Company, P.O. Box 510, Highway 66 East, Stroud, OK 74079, Telephone: (800) 654-9182 or (918) 968-3541.

Sealant: Product 9012

General Information: Product 9012 is a hot-applied, pavement joint sealant material which can be used to seal the joints or cracks in rigid pavements that are exposed to fuel spillage. Product 9012 is manufactured to meet the requirements of Federal Specification SS-S-1614A, ASTM D 3406, ASTM D 3581, ASTM D 3569, ASTM D 1854, and AASHTO M-282. Product 9012 is supplied in solid form and when heated and applied into the joint, cools to form a resilient and adhesive compound that is resistant to weathering, jet fuels, lubricating oils, and will seal joints and cracks against moisture infiltration and debris retention. Product 9012 remains flexible at low temperatures and will not be picked up by pneumatic tires at ambient temperatures. Product 9012 should not be used to seal cracks in asphaltic pavements.

Physical Properties: Typical physical properties and Federal Specification SS-S-1614A results are provided below. The test results do not infer that all lot or batch numbers of Product 9012 will in fact comply with the requirements of Federal Specification SS-S-1614A.

Test	Typical Properties	Test Results for Lot Number Used in Field Evaluation	Federal Specification SS-S-1614A Requirements
Cone penetration, 77°F	1.10 cm	1.15 cm	1.30 cm max.
Fuel-immersed penetration, 77°F	1.05 cm	1.20 cm	1.55 cm max.
Flow, 140°F	0 cm	0 cm	3.0 cm max.
Bond testing, -20°F, 50 percent extension			
Nonimmersed	Pass	Pass	Pass 3 cycles
Water immersed	Pass	Pass	Pass 3 cycles
Fuel-immersed	Pass	Pass	Pass 3 cycles
Change-in-weight	0.67 percent	1.1 percent	±2.0 percent
Recommended pour temp.	260°F	260°F	N/A
Safe heating temp.	280°F	280°F	As recommended

Manufacturer: Koch Materials Company, P.O. Box 510, Highway 66 East, Stroud, OK 74079, Telephone: (800) 654-9182 or (918) 968-3541.

Sealant: Product 9020

General Information: Product 9020 is a two-component, cold-applied, polysulfide based, hand pourable material which is specifically designed for use on civilian and military airfields. Product 9020 is formulated to be resistant to fuel spillage, lubricating oils, and to the direct heat and blast of aircraft engines. Product 9020 is manufactured to meet the requirements of Federal Specification SS-S-200E, Type H, and FAA Specification P-605-2, 1, Type IV. Product 9020 will form an effective seal against the infiltration of water, retention of debris, will be flexible at low temperatures and will not flow or sag from the joints or be picked up by pneumatic tires at temperatures of 200°F or below. Product 9020 cannot be used to seal cracks in asphaltic pavements.

Physical Properties: Typical physical properties and Federal Specification SS-S-200E results are provided below. The test results do not infer that all lot or batch numbers of Product 9020 will in fact comply with the requirements of Federal Specification SS-S-200E.

Test	Typical Properties	Test Results for Lot Number Used in Field Evaluation	Federal Specification SS-S-200E Requirements
Viscosity, poises			
Component A	300 Poise	300 Poise	1,500 Poise max.
Component B	500 Poise	500 Poise	1,500 Poise max.
Working life	3.5 hr	3.5 hr	3 hr min.
Tack free time	4 hr	4 hr	12 hr max.
Accelerated aging	Pass	Pass	No visual or physical change
Self-leveling			
Level plane	1/32 in.	1/32 in.	1/16 in. max
1.5 percent incline	1/16 in.	1/16 in.	1/8 in. max
Change in mass	1.4 percent	1.15 percent	2.0 percent max.
Change in volume	1.1 percent	1.10 percent	5.0 percent max.
Resilience, 77°F			
Unaged			
Indentation	0.08 cm	0.08 cm	0.05-0.20 cm
Recovery	90 percent	90 percent	75 percent max.
Aged			
Indentation	0.07 cm	0.07 cm	0.05-0.20 cm
Recovery	89 percent	89 percent	75 percent min.
Artificial weathering	Pass	Pass	Pass
Bond testing, -20°F, 50 percent extension			
Nonimmersed	Pass	Pass	Pass 3 cycles
Fuel immersed	Pass	Pass	Pass 3 cycles
Water immersed	Pass	Pass	Pass 3 cycles
Flow, 200°F	Pass	Pass	Pass
Flame resistance	Pass	Pass	No ignition, flow or hardening

Manufacturer: Koch Materials Company, P.O. Box 510, Highway 66 East, Stroud, OK 74079, Telephone: (800) 654-9182 or (918) 968-3541.

Sealant: Product 9050 SL-M

General Information: Product 9050 SL-M is a single component, cold-applied, polysulfide based, self-leveling, low modulus material which cures on exposure to moisture. Product 9050 SL-M is without the inclusion of blisters, bubbles, or discontinuities formulated to seal joints or cracks in rigid pavements and is suitable for use in areas that will be subjected to continuous water immersion and hydrostatic water pressure. Product 9050 SL-M will meet the fuel immersed bond test of Federal Specification SS-S-200E and ASTM D 3569 as well as the heat blast resistance requirement of Federal Specification SS-S-200E. Product 9050 SL-M cannot be used to seal cracks in asphaltic pavements.

Physical Properties: Typical physical properties are provided below. The test results do not infer that all lot or batch numbers of Product 9050 SL-M will in fact comply with specified requirements. An industry accepted pavement joint sealant material specification does not exist for this material; therefore, the test method for each test used by the manufacturer is provided.

Test	Test Method	Test Results for Lot Number Used in Field Evaluation	Typical Properties
Sealant consistency	--	Self-leveling	Self-leveling
Viscosity, 77°F	ASTM D 2393	20,000 cps	15,000-30,000
Tack free time	ASTM C 679	45 min	30-75 min
Specific gravity	ASTM D 1475	1.54 g/cm^3	1.5-1.56
Durometer Shore A	ASTM D 2240	17	10-25
Resiliency[1]	ASTM D 3583	83 percent	80 percent min.
Modulus at 150 percent elongation, Die C			
Total elongation, Die C	ASTM D 412	825 percent	800 percent min.
Bond testing[2], -20°F, 100 percent ext. Nonimmersed Fuel immersed Water immersed	ASTM D 3583	 Pass Pass Pass	 Pass 3 cycles Pass 3 cycles Pass 3 cycles
Change in mass[1]	ASTM D 3583	0.94 percent	1.5 percent max.
Change in volume[1]	SS-S-200E	1.01 percent	2.0 percent max.
Flame resistance	SS-S-200E	Pass	Pass
Tensile adhesion	ASTM D 3583	500 percent	400 percent min.
Artificial weathering	ASTM D 3583	Pass	Pass
LOX impact test at ambient temperature, 7.2 ft-lb	NHB 8060.1B Test 13	Pass	[3]

[1] Koch Materials Company sample preparation method used.
[2] Sealant configuration was 1/2 in. by 1/2 in. by 2 in.
[3] Not provided by the manufacturer.

Manufacturer: Mobay Corporation, Inorganic Chemical Division, Mobay Road, Pittsburgh, PA 15205-9741, Telephone: (412) 777-2000.

Sealant: Baysilone 960 Silicone Concrete Joint Sealant

General Information: Baysilone 960 is a single component, low modulus, moisture curing joint sealant formulated to provide a flexible seal for joints in portland cement concrete (PCC) pavements. Baysilone 960 offers weathering resistance and remains elastic and rubbery in temperatures ranging from -40°F to 300°F. Baysilone 960 is manufactured to meet or exceed the requirements of Federal Specifications TT-S-0023C (COM-NBS) and TT-S-001543A (COM-NBS).

Physical Properties: Typical physical properties are provided below. An industry accepted material specification does not exist for pavement silicone joint sealant materials; therefore, the test procedures listed below are those recommended by Mobay Corporation. These results do not infer that all lot numbers of Baysilone 960 will conform to the specified requirements.

Test	Test Method	Test Results for Lot Number Used in Field Evaluation	Typical Properties
Uncured Properties			
Color	--	Gray	Gray
Flow or sag	ASTM D 2202	0.1 in.	0.2 in. max.
Working time	--	[2]	15 min
Tack free time[1]	ASTM C 679	71 min	35-90 min
Through cure 1/4 in.[1]	--	[2]	14 days
Extrusion rate	ASTM C 603	145 gm/min	130 ± 25 gm/min
Specific gravity	--	1.18	1.18 ± 0.02
After cured 21 days at 77°F and 50 percent R.H.			
Durometer Shore A	ASTM D 2240	15	15 ± 5
Modulus at 150 percent elongation, Die C	ASTM D 412	43 psi	35 ± 5 psi
Total elongation, Die C	ASTM D 412	[2]	700 ± 150 percent
Ultimate tensile	ASTM D 412	[2]	90 ± 20 psi
Joint movement	ASTM C 719	[2]	± 50 percent
Bond to concrete	AASHTO T-132	[2]	50 ± 5 percent
Shelf life		[2]	9 months min.
Ozone and U.V. resistance		[2]	No chalking, cracking, or bond loss after 5000 hr

[1] Laboratory conditions 77°F and 50 percent R. H.
[2] Not provided by the manufacturer.

Manufacturer: Mobay Corporation, Inorganic Chemicals Division, Mobay Road, Pittsburgh, PA 15205-9741, Telephone: (412) 777-2000.

Sealant: Baysilone 960 Silicone Self-Leveling Highway Silicone Joint Sealant (This sealant was removed from the market soon after the test section was installed and as of December 1991 had not been replaced with another product).

General Information: Baysilone 960 Self-Leveling is a single component, low modulus, moisture curing joint sealant formulated to provide a flexible seal for joints in portland cement concrete (PCC) pavements. Baysilone 960 Self-Leveling offers weathering resistance and remains elastic and rubbery in temperatures ranging from -40°F to 300°F. Baysilone 960 Self-Leveling is manufactured to meet or exceed the requirements of Federal Specifications TT-S--00230C (COM-NBS) and TT-S-001543A (COM-NBS).

Physical Properties: Typical physical properties are provided below. An industry accepted material specification does not exist for pavement silicone joint sealant materials; therefore, the test procedures listed below are those recommended by Mobay Corporation. These results do not infer that all lot numbers of Baysilone 960 Self-Leveling will conform to the specified requirements.

Test	Test Method	Test Results for Lot Number Used in Field Evaluation	Typical Properties
Uncured Properties			
Color	--	Gray	Gray
Flow or sag	--	Self-leveling	Self-leveling
Working time	--	[2]	15 min
Tack free time[1]	ASTM C 679	137 min	1-2 hr
Viscosity	Brookfield	[2]	20,000-50,000 cst
Specific gravity	--	[2]	1.07
Durometer Shore A	ASTM D 2240	2	4 ± 2
Modulus at 150 percent elongation, Die C	ASTM D 412	31 psi	40 psi max.
Total elongation, Die C	ASTM D 412	[2]	500 percent min.
Ultimate tensile	ASTM D 412	[2]	60 psi min.
Joint movement	ASTM C 719	[2]	±50 percent
Ozone and U.V. resistance		[2]	No chalking, cracking, or bond loss after 5,000 hr

[1] Laboratory conditions 73°F and 50 percent R.H.
[2] Not provided by the manufacturer.

Appendix D
Proposed Specification for Hot-Applied, Non-Jet-Fuel-Resistant Pavement Joint Sealant Primers for Rigid Pavements[1]

1. SCOPE: This specification covers primer materials for use with non-jet-fuel-resistant pavement joint sealant materials when sealing joints and cracks in rigid pavements.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issues in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Federal Specification

SS-S-1401C - Sealant, Joint, Non-Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Asphalt Concrete Pavements

Federal Standards

FED-STD-123 - Marking for Shipment (Civil Agencies)
FED-STD-313 - Material Safety Data Sheets Preparation and the Submission of

Military Standards

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129 - Marking for Shipment and Storage

[1] This proposed specification has not been finalized and changes may occur before it is published as a material specification. Therefore, its use may not be applicable for project specifications.

MIL-STD-147 - Palletized Unit Loads

Federal Regulations

29 CFR 1900-1999 - Occupational Safety and Health Administration (OSHA), Department of Labor

2.2 *Other Publications*. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bid or request for proposal shall apply.

American Society for Testing and Materials (ASTM)

C 711 - Low Temperature Flexibility and Tenacity of One-Part, Elastomeric, Solvent-Release Type Sealants
D 5 - Penetration of Bituminous Materials, Test Method for
D 140 - Sampling Bituminous Materials, Methods of
D 1985 - Preparing Concrete Blocks for Testing Sealants for Joints and Cracks, Standard Practice for
D 2823 - Asphalt Roof Coatings, Standard Specification for

2.3 *Order of Precedence*. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall have precedence.

3. REQUIREMENTS

3.1 *Description*.

3.1.1 *Material*. The primer shall be a single-component, liquid composition that cures after application and which can be spray or brush applied to pavement crack or joint surfaces at temperatures between 50 and 120°F. The manufacturer of the primer shall specify the specific sealant products that are compatible with the primer.

3.1.2 *Performance*. The primer shall cure to form a well-bonded, durable surface coating. The cured primer coating shall be non-tacky and capable of filling and sealing voids in portland cement concrete joint and crack faces. When cured, the primer will assist in restricting passage of moisture through the joint or crack face and will not adversely affect sealant performance.

3.2 *Viscosity*. Viscosity shall be a minimum of 25 cp and shall not exceed 250 cp when tested as specified in 4.4.3.

3.3 *Tack Free Time*. Tack free time shall not exceed 10 min when tested as specified in 4.4.4.

3.4 *Cured Evaluation*. There shall be no reversion to a liquid when conditioned for 60 min at 158°F when tested as specified in 4.4.5.

3.5 *Non-Volatile Content*. Non-Volatile content shall be a minimum of 20 percent and shall not exceed 40 percent when tested as specified in 4.4.6

3.6 *Permeability*. Permeability shall not exceed 10 percent when tested as specified in 4.4 7.

3.7 *Low Temperature Flexibility*. None of the specimens shall develop any cracks greater than 1/4 in. in length or exhibit any adhesion loss when tested as specified in 4.4.8.

3.8 *Adhesion*. None of the specimens shall develop any crack, separation, or opening between the sealant and the concrete block when tested as specified in 4.4.9.

3.9 *Storage Stability*. When specified (see 6.2), the user agency will retain samples for verification of these requirements: The primer, when stored for 2 years from date of delivery, at temperatures from -18°C to 46°F (0°F to 115°F), and tested in accordance with this specification, shall meet all of the requirements herein.

3.10 *Toxicity*. The material shall have no adverse effect on the health of personnel when used for its intended purpose in the manner recommended by the manufacturer. Questions pertinent to this effect shall be referred by the acquiring activity to the appropriate medical service who will act as advisor to the acquiring activity. The manufacturer's instructions shall provide personnel protection to meet OSHA requirements, including 29 CFR 1910.1000, 1910.1002, and 1910.1017, as applicable (see 4.5).

3.11 *Material Safety Data Sheets (MSDS)*. MSDSs shall be prepared in accordance with FED-STD-313 and submitted as directed (see 6.2, 6.3, and 6.5).

4. QUALITY ASSURANCE PROVISIONS

4.1 *Responsibility for Inspection*. Unless otherwise specified, the contractor is responsible for the performance of all inspection requirements and may use his own or any other facilities suitable for the performance of the inspection requirements that are approved by the user agency. The user agency reserves the right to perform any inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 *Materials Inspection*. The contractor is responsible for insuring that supplies and materials are inspected for compliance with all the requirements specified herein and in applicable referenced documents.

4.2 *Classification of Inspections*. The inspection requirements specified herein are classified as follows:

a. Quality conformance inspection (see 4.2.1).

b. Inspection of preparation for delivery (see 4.6).

4.2.1 *Quality Conformance Inspection.* The quality conformance inspection shall be as specified in 4.4. Sampling shall be in accordance with 4.3.

4.3 *Sampling.* Unless otherwise specified (see 6.2), samples for testing shall be taken at the point of manufacturer in accordance with ASTM D 140. It shall be the responsibility of the contractor to determine that the samples taken are representative of the batches for shipment. The representative composite sample of the primer shall consist of not less than 2 liters (0.52 gallons) from each batch. A lot consisting of a single batch, if taken from filled containers, shall be sampled from 3 containers, selected at random, to make up the composite sample. The sample shall immediately be placed in an appropriate airtight sealed container to prevent loss of volatiles prior to testing. Sample identification shall include the name of the testing agency, the contract or purchase order number, and special marking as specified in 5.3.3. Each container from which sample material has been taken shall be sealed and marked for identification.

4.4 *Testing.* Testing shall be conducted at a user-agency approved facility (see 6.2). Samples taken as specified in 4.3 shall be tested as specified in 4.4.1 through 4.4.9. Individual test values, and results of failure analyses of individual shall be recorded. Failure of the primer to pass any test shall be cause for rejection of the lot, except as noted for a marginal test result. The exceptions for marginal test results are as follows: Where test results of only one of the specified tests are judged by the testing agency to be marginal as to meeting the requirements, the testing agency has the option to perform a retest. If the testing agency does not exercise its option to retest, either the contractor or the user agency may request that a retest for that property be made at the requester's expense. Such a test will be made only when an adequate quantity of the original sample is available or where additional material can be obtained from the previously marked sample containers.

4.4.1 *Standard Conditions.* Laboratory atmospheric conditions, hereinafter referred to as standard conditions, shall have a temperature of $23 \pm 2°C$ ($73 \pm 4°F$) and 50 ± 5 percent relative humidity. Specimens shall be stored and tested at standard laboratory conditions unless otherwise specified.

4.4.2 *Specimen Preparation.* Prior to initiating testing, the primer shall be stored at standard laboratory conditions for a minimum of 24 hr to temperature condition the material. Care must be during sample preparation to minimize volatile loss. The sample container must remain tightly sealed at all times except when required for testing purposes. The primer shall be thoroughly mixed to ensure uniformity prior to testing.

4.4.3 *Viscosity.*

4.4.3.1 *Specimen Preparation.* Prepare sample by pouring 700 ± 100 ml of primer into a 1 qt (0.946 L) metal open top can that has a double friction lid. After pouring the primer into the can, seal the can with the double friction lid.

Place the sealed container in a constant temperature water bath maintained at 77±0.2°F for 2±0.5 hr.

4.4.3.2 *Test.* Remove the sealed container from the water bath, dry container, and remove the lid. Stir the sample to ensure uniformity and test using a Brookfield Model HAT viscometer (or equal) using Probe No. 1 and a speed of 50 rpm. Determine conformance to the requirements of 3.2.

4.4.4 *Tack Free Time.*

4.4.4.1 *Specimen Preparation.* Obtain a 2" X 3" X 1" concrete block prepared in accordance with ASTM D 1985. Remove the concrete block from the storage water and scrub the 2" X 3" faces with a stiff bristle brush, under running water. After washing, lightly blot the surfaces of the block with an oil-free, soft absorbent cloth or paper to remove all free surface water. Place the block, with one of the 2" X 1" faces down, on a sheet of blotter paper placed on a plane, solid, nonabsorbent surface. Allow the block to dry at standard conditions for 1 hr.

4.4.4.2 *Block Coating.* Pour approximately 700 ml primer into a 1 qt (0.946 L) open top metal can. Immerse the concrete block totally into the primer for 3 sec. Remove the block from the primer by gripping the 1" X 3" sides using forcepts. Hold the block over the container with the 3" faces in a vertical position for 60 sec.

4.4.4.3 *Testing.* Immediately after the draining period, place the primer coated block with a 2" X 3" side down on a 2" X 3" support as illustrated in Figure 1 placed on a level surface. Allow the specimen to cure for 10 min at standard laboratory conditions. After the 10 min cure time, place a 150 mm X 25 mm X 0.1 mm (6" X 1" X 0.004") polyethylene film on the top surface of the primer coated block with the 6" axis of the film aligned with the 3" axis of the block. Load the polyethylene film for 30 sec with a metal plate approximately 41 mm X 29 mm (1.6" X 1.1"), with not less than 30 or more than 31 g mass. Remove the plate, and withdraw the film, uniformly and progressively, at right angles to the surface of the primer. Primer adhering to the polyethylene film shall constitute failure to conform to the requirements specified in 3.3.

4.4.5 *Cured Evaluation.*

4.4.5.1 *Specimen Preparation.* Prepare one concrete block as specified in 4.4.4.1.

4.4.5.2 *Block Coating.* Coat the concrete block with primer as specified in 4.4.4.2.

4.4.5.3 *Testing.* Test the specimen as described in 4.4.4.3, except allow the specimen to cure for 60 min before applying the polyethylene film and metal plate. After placing the polyethylene film and metal plate on the specimen, place the sample in a forced draft oven maintained at 158°F for 60 min.

Remove the specimen from the oven, remove the metal plate and remove the film uniformly and progressively, at right angles to the surface of the primed block while it is still at temperature. Primer adhering to the polyethylene film shall constitute failure to conform to the requirements specified in 3.4.

4.4.6 *Non-Volatile Content*

4.4.6.1 *Procedure*. Use non-volatile matter determination as specified in ASTM D 2823, Section 8.2. Determine conformance to requirements of 3.5.

4.4.7 *Permeability*.

4.4.7.1 *Specimen Preparation*. Prepare three concrete blocks as specified in 4.4.4.1 except immediately after blotting to remove the free surface water, weigh and record the surface-dried weight of each block (A) to the nearest 0.01 gm. After weighing each block, place them in a forced draft oven set at 135±5°C (275±9°F) and dry them to a constant weight. Constant weight shall be verified by successive weighing using a scale accurate to 0.01 gm on successive hourly weighings. Allow the blocks to cool in a desiccator for 1 hr, then label each block, weigh and record the oven-dried weight (B) to the nearest 0.01 gm, and store in the desiccator until use.

4.4.7.2 *Block Coating*. Coat each block with primer as specified in 4.4.4.2. After allowing the specimen to drain for 60 sec, place the specimen on the support as illustrated in Figure 1 with one of the 2" X 3" sides facing down. Allow the specimen to cure for 4 hr at standard laboratory conditions.

4.4.7.3 *Test Procedure*. After the 4 hr curing period, weigh the coated block to the nearest 0.01 gm and record the weight (C). Then place each block in a 1 liter glass beaker which contains 500±50 ml of distilled water maintained at 25±2°C for 1 hr. At the end of the 1 hr period, remove the blocks from the water and blot the surfaces with an oil-free, soft, absorbent cloth to remove all free surface moisture. Immediately weigh the block to the nearest 0.01 gm and record the weight (D).

4.4.7.4 *Calculations*. Calculate the permeability using the following equation:

$$Permeability = \frac{D - C}{A - B} X\ 100\%$$

A = Saturated surface dried weight of the uncoated block
B = Oven-dried block weight
C = Coated block weight (block and primer)
D = Saturated surface dried weight or coated block

Calculate the permeability for each block and average the results. Determine conformance to the requirements of 3.6.

4.4.8 *Low Temperature Flexibility.*

4.4.8.1 *Specimen Preparation.* Prepare test specimens in accordance with ASTM C 711. Due to the low viscosity of the primer, it will be necessary to seal the interface between the template and the plate with a solvent resistant sealer to prevent leakage of the primer. Fill the sealed template flush with primer and condition the sample for 24±2 hr at standard laboratory conditions. After conditioning, remove the mold by cutting around the edges using a sharp knife.

4.4.8.2 *Testing Procedure.* Place the specimen in a forced draft oven maintained at 158±3.6°F for 16 hr and then further condition the specimen in a freeze maintained at 32±1°F for 1 hr. After conditioning in the freezer for 1 hr, remove the specimen from the freezer and immediately bend the specimen through 180° over a 1/4 in. diameter mandrel with the primer side uppermost. The bend shall be performed in not less than 1 sec and not more than 2 sec. Immediately after bending, examine the primer for cracking, separation, delamination, and adhesion loss. Minor surface crazing or hairline cracks and minor edge cracking shall not constitute failure. Determine conformance to the requirements of 3.7.

4.4.9 *Adhesion.*

4.4.9.1 *Specimen Preparation.* Prepare 6 concrete blocks as specified in 4.4.4.1 and 4.4.4.2. Allow the specimens to cure for 1 hr and then assemble the blocks as specified for the nonimmersed bond test in Fed Spec SS-S-1401. Using a sample of the sealant that is specified by the user agency, heat the sealant and prepare the specimens in accordance to Fed Spec SS-S-1401.

4.4.9.2 *Testing.* Test the specimens in accordance to the nonimmersed bond test procedures of Fed Spec SS-S-1401. Determine conformance to the requirements of 3.8.

4.5 *Toxicological Data and Formulations.* The manufacturer shall provide a listing of the components in the primer that when volatilize could produce hazardous vapors (see 5.3.3). Where precautions need to be taken relative to the inhaling of, or skin or eye contact with the material or vapors, these precautions shall be included in the manufacturer's instructions (see 3.9 and 5.3 3.1).

4.6 *Inspection of Preparation for Delivery.*

4.6.1 *Sampling.* Sampling for inspection of filled containers shall be in accordance with MIL-STD-105, inspection Level II. The unit of product shall be one unit prepared for shipment.

4.6.2 *Examination.* Each filled container selected shall be inspected for conformance to the requirements of Section 5. Inspection shall be based on an Acceptable Quality level of 2.5 percent defective.

5. PREPARATION FOR DELIVERY

5.1 *Packing*. Packing shall be Level A, B, or Commercial as specified (see 6.2).

5.1.1 *Level A*. The material shall be packed in a close-fitting, tapered 24-gage metal pail with gasket and lug cover. Pails shall have a wire handle securely attached to ears or clips which shall be attached to the body of the pails. The exterior surfaces of the pails shall be coated as specified in PPP-P-704. The unit pack quantity shall be one unit of issue quantity specified in the contract or purchase order.

5.1.2 *Level B*. The material shall be packed the same as for Level A except that the exterior surfaces of the pail shall be coated with a commercial coating.

5.1.3 *Commercial*. The material shall be packed to insure carrier acceptance and safe delivery to the destination in containers complying with the rules and regulations applicable to the mode of transportation.

5.2 *Palletization*.

5.2.1 *Level A*. Unless otherwise specified (see 6.2), material shall be palletized in accordance with MIL-STD-147.

5.2.2 *Level B and Commercial*. When specified (see 6.2), material shall be palletized in accordance with MIL-STD-147.

5.3 *Marking*.

5.3.1 *Civil Agencies*. Shipments to civil agencies shall be marked in accordance with MIL-STD-123.

5.3.2 *Military Agencies*. Shipments to military agencies shall be marked in accordance with MIL-STD-129.

5.3.3 *Special Marking*. In addition to the marking of 5.3.1 or 5.3.2, and any special marking of the contract or order, the following information shall be shown on each pail:

a. Name of primer

b. Specification number

c. Manufacturer's name and material designation

d. Manufacturer's lot and batch number

e. Date of manufacturer (month and year)

f. List of hazardous components (see 4.5)

g. Quantity of sealant in pail (net weight)

h. Application temperature

i. Instructions for use

5.3.3.1 *Instructions for Use.* The instructions for use (see 6.7) shall include, but not limited to the following: ambient temperature and humidity ranges, and moisture conditions of joints, for successful installation; essential requirements for preparation of joints, handling, placing, and disposal of primer materials; and any restrictions to be adhered to in order to reduce hazards to personnel or to the environment. If it is not feasible to include all the instructions on the container without sacrificing legibility, the most important information shall be shown on the container and the full instructions referenced and furnished separately.

6. NOTES

6.1 *Intended Use.* This primer is intended for use with joint sealant materials for sealing joints and cracks in rigid pavements that are not subjected to the spillage of jet fuels and lubricating oils. It is not intended to be resistant to the heat and blast of jet aircraft engines, except when aircraft are moving at moderate speeds.

6.2 *Ordering Data.* Purchasers shall select the preferred options permitted herein, and include the following in procurement documents:

a. Title, number and date of this specification

b. When stability samples are required, quantity to be retained and by what activity (see 3.7) and 6.4)

c. Addresses for submission of MSDS (see 3.9 and 6.5)

d. Sampling, if other than as specified (see 4.3)

e. Designation of Government approved test facility (see 4.4)

f. Level of packing required (see 5.1)

g. If palletization is not required for Level A (see 5.2.1)

h. When palletization is required for Level B or Commercial (see 5.2.2)

6.3 *Data Requirements.* When this specification is used in an acquisition which incorporates DD Form 1423, Contract Data Requirements List (CDRL) and invokes the provisions of paragraph 52.227-7031 of the Federal Acquisition Regulations (FAR), the data requirements will be developed as specified

by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL (DD Form 1423) incorporated into the contract. When the provisions are not invoked, the data shall be delivered in accordance with the contract requirements (see 3.10).

6.4 *Stability Samples.* The date of delivery shall be marked on samples submitted for stability testing (see 3.7).

6.5 *MSDS Submission and Forwarding.* MSDS copies shall be forwarded to the designated Industrial Hygienist and the focal point of the activity that purchased the item, and the focal point of the using activity if different from purchasing activity. After review and acceptance of MSDS by designated recipients, approved copies will be forwarded to arrive at the destinations prior to material delivery (see 3.9).

6.6 *Availability of Testing Materials and Apparatus.* Known suppliers of specified testing materials and apparatus are as follows:

6.6.1 *Solvent Resistant Sealer.* Permeatex No. 2 Pliable, Non-Hardening, Gasket Sealant, Locktite Corporation, Automotive and Consumer Group, Kansas City, KS 66115.

6.6.2 *Release Agent.* An agent as specified in 4.4.5.1: Dow Corning 20 release coating, Dow Corning Corporation, Midland, MI 48640.

6.6.3 *Concrete Blocks.* Blocks as specified in 4.4.6.2: U.S. Army Corps of Engineers, Missouri River Division Laboratory, 420 South 18th Street, Omaha, NE 68102.

6.6.4 *Blotting Paper.* Paper as specified in 4.4.6.3: White Reliance Blotting Paper, Product Code 13-01-12, James River Paper Company, Incorporated, 145 James Way, Southhampton, PA 18966.

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13. ABSTRACT *(Maximum 200 words)*

This report documents the field evaluation phase of the joint effort research program conducted by Crafco, Incorporated, and the U.S. Army Engineer Waterways Experiment Station. The project was funded under the auspices of the FY 89 Construction Productivity Advancement Research (CPAR) Program. The objectives of the research effort were to (a) develop specification limits for a hot-applied, jet-fuel-resistant (JFR) sealant with improved performance characteristics as compared to current Federal Specification (FS) SS-S-1614A type materials, (b) develop specification limits for a hot-applied, non-jet-fuel-resistant (non-JFR) sealant with improved low temperature performance characteristics as compared to current FS SS-S-1401C type materials, (c) develop specification limits for a primer system that will minimize the bubbling tendencies associated with hot-applied sealants and improve adhesion characteristics to portland cement concrete (PCC), and (d) develop field data to determine performance characteristics of flush fill sealant application geometry versus 1/8 to 1/4 in. recess application techniques. The objectives were expanded to include field comparisons of the laboratory developed JFR and non-JFR sealants versus commercially available sealant materials and to verify that the developed primer system minimized bubbling tendencies of hot-applied sealants.

(Continued)

14. SUBJECT TERMS
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Coal tar-based sealants
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13. (Concluded).

The field evaluation site selected for this project was Fairchild Air Force Base (AFB), WA. The 6 month and 1 year evaluations indicate that none of the sealants experienced any adhesive or cohesive failures except in areas that could be attributed to snow plow damage or areas of the joint face that were not completely clean when the sealant was installed. The hot-applied, asphalt-based materials had experienced a large amount of bubbling but the bubbling had not affected the sealants performance. It is believed that the bubbling could affect the field performance of these materials within the next year. The cold-applied sealants, both single-component and two-component, appeared to be performing better than the hot-applied sealants. However, because of the brevity of the evaluation period, it is difficult to predict which material will perform the best.

14. (Concluded).

Jet-fuel-resistant sealants
Non-jet-fuel-resistant sealants
Polysulfide-based sealants
Silicone-based sealants
Two-component sealants